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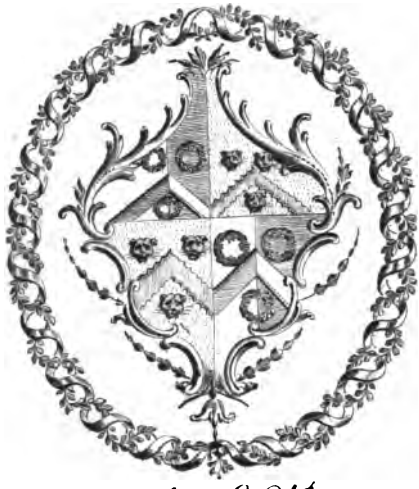

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ASTRO-THEOLOGY

Or a *Demonstration* of the

BEING and ATTRIBUTES

OF

GOD,

From a SURVEY of the

HEAVENS.

Illustrated with Copper Plates.

By W. DERHAM, Rector of *Upminster* in *Essex*, and F. R. S.

The Second Edition, Corrected.

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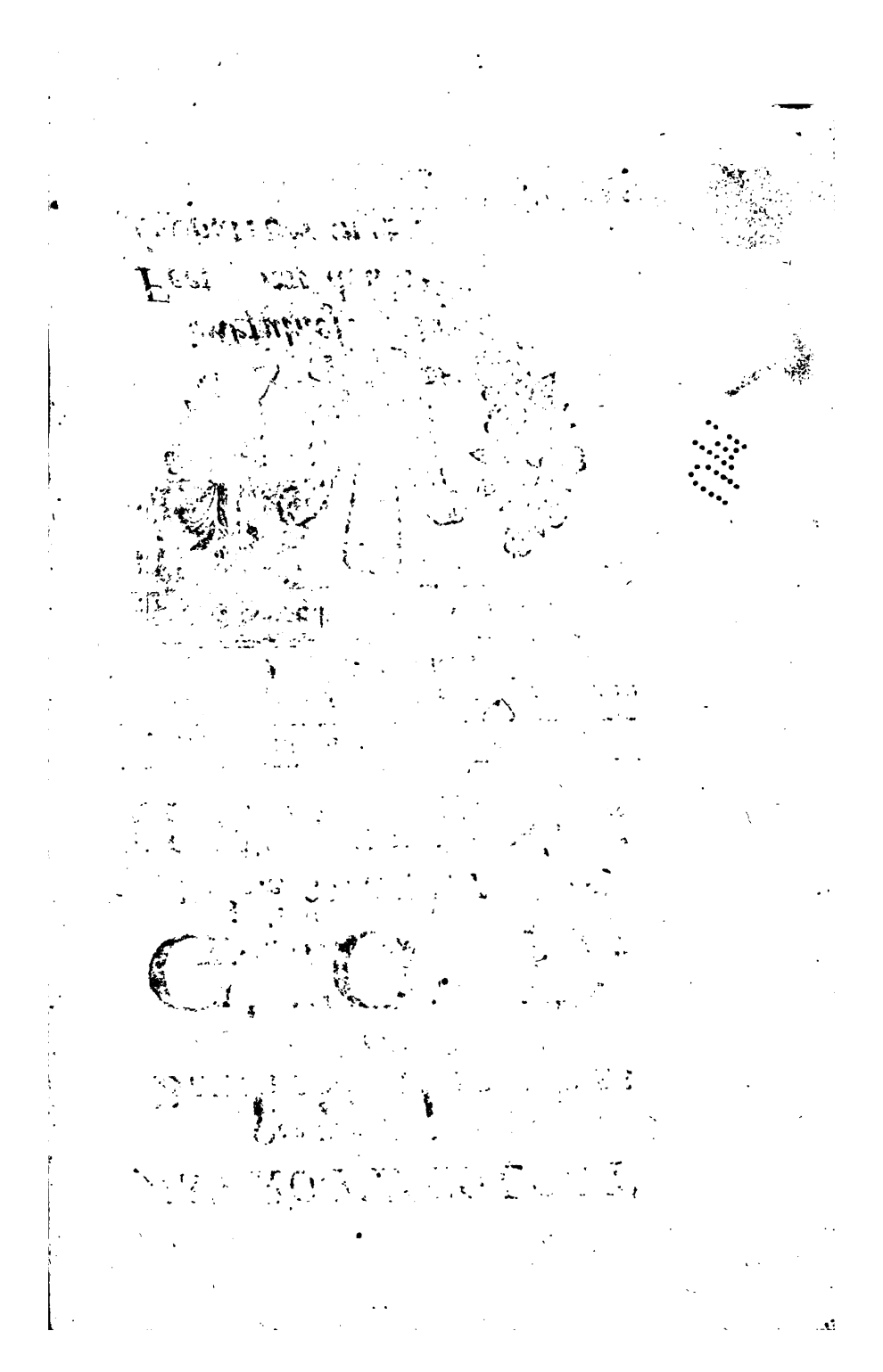

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To His Royal Highness

GEORGE,

Prince of *WALES*, Prince Electoral of *Brunſwick-Lunenburg*, &c.

Duke of *Cornwall* and *Rothſay*, Duke and Marqueſs of *Cambridge*, Earl of *Cheſter*, *Milford Haven*, and *Carrick*, Viſcount *Northallerton*, Baron of *Tewkeſbury* and *Renfrew*, Lord of the Iſlands, and Steward of *Scotland*, and Knight of the moſt Noble Order of the *Garter*.

GREAT SIR,

YOUR Royal Highneſs *having done me ſo great an Honour, as to take this Book under your Patronage, with great Humility and Thankfulneſs I lay it at your Feet; not doubting, but that (whatever my Performance is) the*

the Subject will be acceptable, it being a Vindication of the Exiſtence *and* Attributes *of that infinite* BEING, *to whom your* Royal Highneſs *hath, no leſs piouſly than juſtly, aſcribed your great* Royal FATHER's, *and your* Family's *peaceable Acceſſion to the Crown and Dignity of theſe Realms.*

THAT *the Bleſſings of the ſame moſt merciful* BEING *may be perpetuated to your* Royal Highneſs *and all* Yours, *is the hearty Prayer of,*

Moſt Illuſtrious SIR,

Your *Royal Highneſs's*

moſt humble obedient

Servant,

W. Derham.

A

Preliminary Diſcourſe,

CONCERNING

The Syſtemes of the Heavens, the Habitability of the Planets, and a Plurality of Worlds: Uſeful for the reading of the following Book.

MY *Phyſico-Theology* having met with ſo quick a Sale as to come to a third Impreſſion before the Year was expired, but eſpecially the ſollicitations of many Learned men, both known and un-

unknown, have given me great encouragement to fulfil my promiſe, in ſending abroad this other Part, relating to the *Heavens*: which ſhould ſooner have ſeen the light, but that I was minded not to interrupt the Reader's patience with many Notes (which I could not well avoid in my *Phyſico-Theology*, and which my Rough-Draught of this was burthened with) and therefore I threw the greateſt part of them into the Text: which neceſſitated me to tranſcribe the whole. And when my Hand was in, I new-made ſome part of it, and added many new Obſervations of my own, which I have lately made with ſome very good long Glaſſes I have in my hands; one of *Campani*'s grinding; and others of *Engliſh* work, which exceed it; but eſpecially one of Mr. *Huygens*'s of about 126 feet, which few for goodneſs do ſurpaſs.

OF theſe Obſervations the Reader ſhould have met with many more (and I believe ſome of my ingenious Friends do expect more) but that I lay under two inconveniences. One the want of an open free Horizon, my Habitation being ſurrounded much with Trees. The other, and indeed the chief, the want of a long Pole, of 100 or more feet, to raiſe my long Glaſs to ſuch an height as to ſee the Heavenly Bodies above the thick Vapours, which much obſcure all Objects near the Horizon, eſpecially when viewed with long and good Glaſſes. But as I have been at conſiderable expences already about theſe matters, and this I am informed would amount to 80 or 90 *l.* I thought it much too great a burthen for the yearly Income of my Living.

AND therefore if I have not ſufficiently anſwered the expectations of

ſome of my learned and ingenious Friends, I hope they will excuſe me, and believe it to be more my Calamity than Fault that I have done no more; eſpecially among ſuch Planets as have advantageouſly preſented themſelves, as *Saturn* particularly hath, whoſe 5 or more *Satellites* it may be expected I have ſeen; but I could never reach but three of them, and they only when there were but few Vapours. And as for the Spots in *Mars* and *Venus*, and their Motion round their own Axes, I confeſs I have not yet had good Views of thoſe Planets, ſince I have had my furniture of Glaſſes, by reaſon of the too great diſtance of *Mars* from the Earth, and the proximity of *Venus* to the Sun, and of late the cloudy weather, and the ſmall altitude which *Venus* hath above the Horizon. But if I can obtain a ſufficient Apparatus, and God is pleaſed to grant me Life, Health, and

and Leiſure, I hope to compenſate for my Defects.

But however, what is here wanting in my own, is ſufficiently made up from the Obſervations of others. Of which the learned World hath good ſtore ſince the Invention of the Teleſcope; which as it hath made ample diſcoveries of the Works of God, ſo hath laid open a new, and a far more grand and noble ſcene of thoſe Works than the World before dreamt of, and afforded us a far more Rational Syſteme of the Heavens and the Univerſe, than was before entertained.

And forasmuch as I have frequent occaſions in my following Book to ſpeak of, and according to, this and ſome of the other Syſtemes, it is neceſſary I ſhould, by way of Preface, give ſome account of them, to enable ſuch perſons to read my Book as are unacquainted with Aſtronomical matters.

AMONG all the various *Systemes*, I need take notice only of three, the *Ptolemaick*, the *Copernican*, and the *New Systeme*. Of each of which in their Order.

Of the Ptolemaick *Systeme.*

IN the *Ptolemaick Systeme* the Earth and Waters are supposed to be in the Center of the Universe; next to which is the Element of *Air*, and next above that is the Element of *Fire*: next that the Orb of *Mercury*; then that of *Venus*, then that of the *Sun*; and above the Sun's Orb, those of *Mars*, *Jupiter* and *Saturn*; and above them all, the *Firmament* or Orb of the *Fixt Stars*; then the *Crystalline Orbs*; and lastly the *Calum Empyreum*, or *Heaven of Heavens*. All these massy Orbs, and vast Bodies born by them, are, in this Systeme, supposed to move round the terraqueous Globe once in 24 hours;

hours: and besides that, in some other certain periodical times. For the effecting of which Motions, they were forced to contrive such Circles as they called *Eccentricks* and *Epicycles*, crossing and interfering with one another; which I could not represent in so narrow a compass as *Fig.* 1. is, which is a Scheme of this *Ptolemaick Systeme*; which is universally maintained by the *Peripatetick* Philosophers.

Of the Copernican *Systeme.*

The next *Systeme* is the *Pythagorean* or *Copernican*, being invented as some imagine by *Pythagoras* himself. But *Diogenes Laertius* (1) expresly saith, That *Pythagoras*'s opinion was, *That the World was round, containing the Earth in the midst of it.* And by *Pliny*'s account (2) of *Pythagoras* his Distan-

(1) Lib. 8. in Pythagorâ.
(2) Nat. Hist. L. 2, c. 21, 22.

ces,

ces, and Orders of the Planets, this ſeems to have been his opinion. But the ſame *Laertius*(3) affirms *Philolaus* the *Pythagorean* τὸν Γῆν κινεῖσθαι κατὰ κύκλον, πρῶτον εἰπεῖν. οἱ δέ, Ἱκέταν Συρακούσιον φασίν; *to have been the firſt that ſaid the Earth was moved in a Circle: but ſome ſay* Hicetas *the* Syracuſian. So *Plutarch* in his *Life of Numa*, ſpeaking of *Numa*'s building *The Temple of* Veſta, ſaith, *he built it round, and that a continual fire was kept therein in imitation of the figure of the Earth, or rather of the whole World it ſelf, the middle of which the* Pythagoreans (not *Pythagoras*) *take to be the Seat of Fire.*

THIS Syſteme (whoever was the Inventer of it) *Copernicus*, a *Canon* of *Tourain* reſtored about the beginning of the 15th Century, and was followed therein by many conſiderable men,

(3) Ibid. in Philolao.

as *Rheticus*, *Mæſtlinus*, *Kepler*, *Rothman*, *Bullialdus*, *Lansberge*, *Herigonius*, *Schickard*, *Gaſſendus*, *Galilæo*, and others. The laſt of which (by the ill will and inſtigation of Pope *Urban* VIII. as 'tis ſuppoſed) had the misfortune to fall under the cenſure of, and to have his *Copernican Tenets* condemned by the Inquiſition, and was forced to abjure them. The particulars of which, if the Reader hath a mind to ſee, he may find them in *Riccioli's Almageſt.* (4).

ACCORDING to this Syſteme, the *Sun* is ſuppoſed to be in the Center, and the Heavens and Earth to revolve round about him according to their ſeveral Periods: firſt *Mercury* in near 88 days; then *Venus* in ſomewhat above 224 days; then the *Earth*, with its Satellite the *Moon*, in

(4) Lib. 9. Sect. 4. Cap. 40.

365 days; then *Mars* in about 687 days; then *Jupiter* with his four Moons in about 4333 days; and laſtly, *Saturn* in ſomewhat above 10759 days, with his 5 or more Moons revolving about him. And beyond or above all theſe is the *Firmament*, or the Region of the *Fixt Stars*, which are all ſuppoſed to be at equal diſtances from their Center, the Sun.

THIS is the *Copernican Syſteme*, which I have given a Scheme of in *Fig.* 2. And ſo far as this Syſteme relates to the Motion of the Earth, and the Sun reſting in the Center, I prefer it to the *Ptolemaick Hypotheſis* on theſe *Five* following accounts.

1. Becauſe it is far more agreeable to Nature, which never goes a round-about way, but always acts by the moſt compendious, eaſy and ſimple methods. And in the *Copernican* way, *that* is performed by one, or a few eaſy Revolutions, which, in

the other way, is made the work of the whole Heavens, and of many ſtrange and unnatural Orbs. Thus the Diurnal Motion is accounted for by one Revolution of the Earth, which all the whole Heavens are called in for, in the other way; So for the Periodical Motions of the Planets, their Stations, Retrogradations and Direct Motions, they are all accounted for by one eaſy, ſingle Motion round the Sun, for which, in the *Ptolemaick* way, they are forced to invent divers ſtrange, unnatural, interfering *Eccentricks* and *Epicycles*. An Hypotheſis ſo bungling and monſtrous, as gave occaſion to a certain King to ſay, *If he had been of God's Council when he made the Heavens, he could have taught him how to have mended his Work.*

2. As the *Copernican* is far more eaſy and agreeable to Nature than the *Ptolemaick* Syſteme, ſo it is far more compleat

pleat, and answerable to the various Phænomena of the Planets; several of which the *Ptolemaick* Hypothesis either very awkwardly solves, or does not at all come up to, of which instance here in divers particulars relating to *Venus* and *Mercury*, as why the Earth is never between them and the Sun, which the *Ptolemaick* Systeme gives no tolerable account of, and but poor accounts of other of their Phænomena, as also of those of the Moon and the other Planets. I might shew also how incoherent and improper the Motions assigned to the Heavenly Bodies are in the *Ptolemaick* way, as that the Moon should move round once in a Month, the other Planets in such and such Periods as are assigned to them, the Firmament, or Fixt Stars in 25868 years, the Sphere beyond that in 7000 years, the Tenth Sphere in 1000 years, and the outermost of all, the

Primum

Primum Mobile, which moves all the reſt in only 24 hours. Which are Motions ſo unproportional and diſagreeable, that are ſufficient to ſubvert the whole Hypotheſis. But it would be endleſs to enter into a detail of ſuch incoherences and improprieties as the *Ptolemaick* Syſteme abounds with.

3. The prodigious and inconceivable Rapidity aſſign'd by the *Ptolemaicks* to the Heavens, is by the *Copernican* Scheme taken off, and a far more eaſy and tolerable Motion ſubſtituted in its room. For is it not a far more eaſy Motion for the Earth to revolve round its own Axis in 24 hours, than for ſo great a number of far more maſſy, and far diſtant Globes, to revolve round the Earth in the ſame ſpace of time? If the Maintainers of the *Ptolemaick* Syſteme do object againſt the Motion of the Earth, that it would make us dizzy,

and ſhatter our Globe to pieces, what a precipitant, how terrible a Rapidity muſt that of the Heavens be? What a Velocity muſt the Sun have to run its courſe, at the diſtance of 21 or 22 Semidiameters of the Earth? What a Velocity muſt that of the Fixt Stars, eſpecially that of the *Primum Mobile* be, at far greater diſtances than the Sun is?

4. It is an inconteſtable argument of the *Sun* being the Center of the Planets about him, and not the *Earth*, that their *Motions* and *Diſtances* reſpect the Sun, and not the Earth. For with regard to the Sun, the Primary Planets have a very due Motion, in proportion to their ſeveral Diſtances; that is, Their Motions round the Sun, are in ſeſquiplicate Proportion to their Diſtances from him; but this Proportion doth not hold at all with relation to the Earth. But as for the Secondary Planets, round *Saturn*,

Jupi-

Jupiter and the *Earth*, it is very certain that they have the same respect to their Primaries, as these Primaries have to the Sun; that is, *The Squares of their Revolutions are as the Cubes of their Distances.* And as it is very certain and visible, that the Secondary Planets respect their Primaries as their Centers, and move round them; so it is in some measure (one would think) no less certain, and beyond doubt, that all the Primary Planets, which have the self-same respect to, and Motion with regard to the Sun, as those Secondaries have to their Primaries, that those Primaries, I say, do move round him as their Center, and not about the Earth, to whom they have no such respect.

The last Argument I shall alledge for my preference of the *Copernican* to the *Ptolemaick Systeme*, is from the great Parity and Congruity observable among all the works of the Creation; which

have a manifeſt harmony, and great agreement with one another.

Thus in our preſent caſe, it is manifeſt to our ſighe, that every Globe we have any good views of, hath ſuch like Motions, as thoſe are which we aſcribe to the Earth. The Sun indeed being in the Center, is as 'twere fixt there, and hath no Periodical Motion: but yet the other Motion round its own Axis, we can manifeſtly diſcern. And as for all the Planets which move round about the Sun, they have, as far as 'tis poſſible for us to ſee them, ſuch Motions as thoſe we aſcribe to the Earth; namely, a Diurnal Rotation round their own Axes, and a Periodical Revolution round the Sun. And if this be manifeſt in the other Planets, what ſhould hinder its being ſo in our own? Why ſhould ours be ſingular? Why not be ſuppoſed to be moved as well as the reſt, when it is very certain

tain that either it hath those Motions, or the Heavens have so; and it is far more natural and easie for the Earth to perform them, than for the Heavens, as hath been already shewn.

Thus having shewn how far more probable the *Copernican* Systeme is than the *Ptolemaick*, so far as it relates to the Motions of the Heavens and Earth, and the Sun being in the Center; it remains (before I proceed to the *Third* and last *Systeme*) that I should answer some Objections alledged against this Systeme, partly from *Scripture*, and partly from *Philosophy* and *Sight*.

The Objections from *Scripture* are such as seem to assert the Immobility and Rest of the Earth, and the Motion of the Sun and Heavenly Bodies.

The Texts that are brought to prove the Immobility and Rest of the Earth, are 1. *Chron.* 16. 30. *The World shall be stable, that it be not*

moved. The ſame is ſaid, *Pſal.* 93. 1. *The World alſo is eſtabliſhed, that it cannot be moved.* And ſo the ſame again, *Pſal.* 96. 10. In *Pſal.* 104. 5. GOD is ſaid to *lay the foundations of the Earth, that it ſhould not be moved for ever.* And laſtly *Solomon, Eccleſ.* 1. 4. aſſerts that *The Earth abideth for ever.* Like to which is that of the *Pſalmiſt*, Pſal. 119. 90. *Thou haſt eſtabliſhed the Earth, and it abideth.* Theſe are the principal Texts which ſeem to aſſert the Immobility and Stability of the Earth.

THE principal Texts which mention the Motion of the Sun and Heavenly Bodies, are ſuch as aſcribe Riſing, Setting or Standing ſtill to them. Thus *Gen.* 19. 23. *The Sun was riſen upon the Earth, when Lot entered into Zoar.* And *Gen.* 15. 17. *When the Sun went down, and it was dark, a ſmoaking Furnace,* &c. So *Eccl.* 1. 5. *The Sun ariſeth, and the Sun goeth down, and haſteth to the place where he aroſe.*

So

So *Pſal.* 19. 5, 6. the Sun is ſaid to *come out of his chamber like a Bridegroom, and to rejoyce as a ſtrong man to run a race. That his going forth is from the end of the Heaven, and his circuit unto the ends of it.* Purſuant to which expreſſions of the *Sun's moving*, it is ſaid alſo to *ſtand ſtill*, and to *go backwards.* Thus *Joſh.* 10. 12, 13. *Sun, ſtand thou ſtill upon* Gibeon, *and thou Moon in the valley of* Ajalon. *And the Sun ſtood ſtill, and the Moon ſtayed.— So the Sun ſtood ſtill in the midſt of Heaven, and haſted not to go down about a whole day.* And in 2 *King.* 20. 10. and *Iſai.* 38. 8. the *Sun* is ſaid *to have returned ten degrees backward* in one of the places, and *its Shadow* to have done ſo in the other.

THESE are the chief Texts of *Scripture*, which ſeem to lie againſt the *Copernican* Hypotheſis. In anſwer to which, this may be ſaid in gene-

ral to them all; That ſince the deſign of the holy Writings is not to inſtruct Men in Philoſophical, but Divine matters, therefore it is not neceſſary to reſtrain the ſenſe of thoſe Texts to the ſtrict propriety of the Words, but take them to be ſpoken according to the appearance of things and the vulgar notions and opinions which men have of them, not according to their reality, or Philoſophical verity. Thus in divers other inſtances the holy Scriptures ſpeak; and thus even Philoſophers themſelves ſpeak. Yea, the *Copernicans* themſelves, although they profeſſedly own, and defend the contrary; yet in vulgar ſpeaking in our preſent caſe, ſay, The Sun riſeth, ſetteth, and moveth, *&c.* making that to be the act of the Sun in vulgar diſcourſe, which they contend to be in reality performed by the Earth. And if Philoſophers, and others did not

thus

thus expreſs themſelves according to the appearance of things, and mens vulgar apprehenſions of them, it would need a Comment, and they muſt explain themſelves every time they ſpeak, in order to their being underſtood.

HAVING given this general Anſwer, I ſhall next conſider the particular Texts themſelves, and ſee whether they neceſſarily infer what they are brought for the Proof of.

AND in the firſt place, as for the Texts brought to prove the Immobility of the Earth, it is manifeſt that the *Stability of the World*, mentioned in the three firſt Texts, doth not relate to the Earth's motion, either Annual or Diurnal, but to the Condition, State and Order of the World inhabiting the Earth, particularly the Peace and Proſperity thereof. One of our own lateſt, and moſt learned Commenta-

tors

tors, the late Biſhop *Patrick* (5) underſtands the Goſpel ſtate to be meant in the firſt and third of the Texts. And his Paraphraſe on that in *Pſal.* 93. 1. is, *He who made the World, will ſupport that excellent order wherein we are ſettled; ſo that it ſhall not be in the power of man to diſturb what he hath eſtabliſhed.*

As for what is ſaid in *Pſal.* 104. 5. it is manifeſt that the *Pſalmiſt* is there celebrating the Works of Creation, and that there was as fair an occaſion of ſpeaking of the Earth's Reſt, in relation to its two Motions, as any where. But yet even here alſo the ſecurity and permanency of its State is the thing aimed at. The laſt moſt learned Commentator thus Paraphraſes on the place (6), *Who hath*

(5) See his *Commentary on Chron.* and his *Paraphraſe on Pſalms.*

(6) Biſhop *Patrick's Paraph. on Pſal.* 104. 5.

ſettled

ſettled the maſſy Globe of the Earth, even in the liquid air, upon ſuch firm foundations, that none of thoſe Storms and Tempeſts, which beat upon it from without, nor any Commotions from within, can ever ſtir it out of the place he hath fixed for it.

As for the two remaining places in *Eccleſ.* and *Pſal.* 119. it is plain enough that their Deſign is to ſhew the Vanity and Inſtability of the things of this World, that they are all more fleeting and uncertain than other matters, even than the Earth it ſelf, on which they have their reſidence. In *Eccleſ.* the wiſe man (who had undertaken to prove all things here below to be Vanity) begins with the State of Man himſelf, and ſhews that to be more fickle and tranſitory than the Earth, on which the various Generations of Men live, and to which their Bodies do all return again. The *Generations of men paſs away; but the Earth abideth for ever,* in the ſame

ſame unalterable condition, without ſuch going and coming, as that of the Generations of men have.

In *Pſal.* 119. 90. the *Pſalmiſt* celebrates *God's Faithfulneſs* to all the various and ſucceeding Generations of the World, which he ſhews to be as conſtant and unalterable as the Earth it ſelf, which GOD hath ſo eſtabliſhed, that it abideth through all the ſeveral Generations of men, when they at the ſame time are fleeting and changing.

Thus it appears that all thoſe ſeveral Texts which aſſert the *Stability of the World*, or *Earth*, prove nothing againſt the *Earth's* Motion in a Philoſophical ſenſe; only expreſs ſome Moral, Theological Truths.

And ſo the ſame may be ſaid of thoſe other places of Scripture, which mention the Motion of the Sun and other Heavenly Bodies, that ſay they Riſe, Set, and perform the Motions which

which the *Copernicans* aſcribe to the Earth. If we ſhould take theſe Expreſſions in a philoſophical, ſtrict, literal ſenſe, and not as vulgar Expreſſions, ariſing from the appearance of things; we ſhall find that very odd and unreaſonable Concluſions may as well be collected from thoſe Scriptures, as the Sun's Motion: as that the Sun hath animal Life, Motion, and Deſire, being ſaid to act theſe things it ſelf, to riſe, to ſet, yea to *haſte to the place* of his Riſing, or as the Hebrew hath it, to *pant after*, or *eagerly to deſire* it (7). So in *Pſal.* 19. the elegant *Pſalmiſt* giving a poetical deſcription of this noble and admirable work of GOD, the *Sun*, ſaith, GOD hath, in the Heavens, *made a Tabernacle for him*; as if the Sun had an Houſe, a Reſting place provided for

(7) חשק Anhelavit, inhiavit. vid. *Buxtorf. Lexicon.*

him; from which he comes daily forth with beauty and luſtre, as reſplendent as that of a Bridegroom; and with the ſame ardency, joy, and diligence runs his Courſe, as a Champion doth his Race. And laſtly his *Going forth* is ſaid to be *from the end of the Heaven, and his Circuit* to reach *to the ends thereof*; as though the Heavens had two Extremities, or was, as the Ancients fancied the Earth to be, a long large Plane bounded by the Ocean, under which they imagined the Sun betook himſelf, and was thence ſaid *Tingere ſe Oceano*, to *dip himſelf into the Ocean* when he Set.

And as in theſe places of Scripture the Sun is ſaid to *Move*; ſo in other places he is ſaid to *ſtand ſtill*, and to *go backward*. But we ſhall find that very abſurd concluſions would follow the taking thoſe Texts in a ſtrict literal ſenſe. For in *Joſhua* the Sun is ordered to *ſtand ſtill upon* Gibeon;

Gibeon, *and the Moon in the valley of* Ajalon. But it would be very absurd to take this in a literal ſenſe, and imagine thoſe two great Luminaries were confined to thoſe two places, otherwiſe than in appearance to the victorious *Iſraelites*. And if ſo conſiderable a part of the tranſaction be ſpoken according to its appearance, why not the whole? Why might not this Station as well be an Arreſt of the Earth's motion, as of that of the Heavens, if the whole Miracle was not (as ſome not improbably think) effected by means of ſome preternatural Refractions, or extraordinary Meteors, *&c.*

And ſo for the Receſs of the Sun, or its Shadow in *Hezekiah*'s caſe, that which in appearance ſeemed to be the action of the Sun, is by divers learned men thought to have been the effect of ſuch like extraordinary Refractions or Meteors, as I mentioned

ned in the laſt caſe: or if it was a real Receſs, why not of the Earth, rather than the Sun and whole Heavens?

Thus having anſwered the particular Texts, it doth not appear that the Scriptures oppoſe the *Copernican Syſteme*, but that thoſe paſſages which ſeem to do ſo, are ſpoken more according as things appear than as really they are. For as St. *Hierom* ſaith, (8) *Conſuetudinis Scripturarum eſt — It is the cuſtom of the Striptures, for the Hiſtorian ſo to relate the opinion men had of many matters, as at that time thoſe matters were by all people taken to be.* And in another place (9) *There are many things in the Holy Scriptures, which are ſpoken according to the opinion of the time in which they were done, and not*

(8) *Hieron. in Matth.* c. 13.
(9) In *Jerem.* 28.

accor-

cording to their reality. And this is no other than what is very reasonable, and suitable to the end and design of the Holy Scriptures, which, as I have said, is rather to instruct men in *Divine and Moral Doctrines*, than *Philosophical Truths*. And agreeably hereto St. *Auguſtine* anſwers this very doubt concerning the Motion of the Heavens (9). *Some of the Brethren* (ſaith he) *move a Queſtion, whether the Heavens ſtand ſtill or are moved, becauſe, ſay they, if they are moved, how is it a Firmament? and if they ſtand ſtill, how do the Stars, which are believed to be fixt in them, revolve from Eaſt to Weſt, the Northern Stars deſcribing leſſer Circles near the Pole?—To which,* ſaith he, *I anſwer, That theſe things do greatly require ſeveral ſubtile and laborious Reaſons, to diſcover truly whether the matter be ſo,*

(9) Auguſt. de Geneſi ad Literam. L.2.c.10.

or not ſo. For the entering upon, and diſcuſſing of which, I have neither time, neither is it fit it ſhould be done to ſuch as we deſire to inſtruct in the way of Salvation, for the neceſſary benefit of the holy Church.

HAVING thus anſwered the Objections from Scripture, I ſhall in the laſt place conſider thoſe brought from Senſe and Philoſophy.

THE Objection from *Senſe* is, That we ſee the Heavenly Bodies actually to move, and therefore ought to believe they do ſo. But there is no weight at all in this, becauſe whether we our ſelves, or the Object moveth, it amounts to the ſame. As is manifeſt to any one carried in a Boat or Chariot; the Progreſſive motion of which, produceth the appearance of a Regreſſive motion in the unmoved Objects we look upon; according to *Virgil*'s deſcription

tion of *Æneas* and his company's leaving their Port (10).

Provehimur portu, terræque urbesque recedunt.

i. e. *Both Land and Towns receded when we left our port.* As for the reason hereof, I shall refer to the Opticians, particularly the famous *Kepler*, who in his *Optices Astronom.* hath designedly handled this point.

THE Objections from *Philosophy* are too numerous to be distinctly answered, especially such as seem very frivolous, particularly those grounded on a supposition of the Verity of the *Aristotelian* Philosophy, as the Immutability and Incorruptibility of the Heavens, &c. For answers to which I shall refer the Reader to *Galilæo's System. Mund.* But for such Objections as seem to have some reason in

(10) Æneid. L. 2. Car. 72.

them, they are chiefly theſe, That if the Earth be moved from W. to E. a Bullet ſhot Weſtward would have a farther Range, than one ſhot Eaſtward; or if ſhot N. or S. it would miſs the mark; or if perpendicularly upright, it would drop to the Weſtward of the Gun. That a Weight drop'd from the top of a Tower, would not fall down juſt at the bottom of the Tower, as we ſee it doth. That Birds flying towards the E. would be hindered in their Flight, but forwarded in flying the contrary way; with much more to the ſame purpoſe. But not to enter into a Detail of Anſwers that might be given from the Laws of Motion, and the Rules of Mechanicks and Mathematicks, I ſhall only make uſe of the moſt ingenious *Galilæo*'s plain Experiment, which anſwereth all or moſt of the Objections (11). *Shut*, ſaith

(11) *Syſtem. Mund. Dial.* 2.

he,

he, your ſelf up with your friend in the Great Cabin of a Ship, together with a parcel of Gnats and Flies, and other little winged creatures. Procure alſo a great tub of water, and put Fiſhes therein. Hang alſo a Bottle of Water up, to empty it ſelf drop by drop into another ſuch Bottle placed underneath with a narrow neck. Whilſt the Ship lies ſtill, diligently obſerve how thoſe little winged creatures fly with the like ſwiftneſs towards every part of the Cabin; how the Fiſhes ſwim indifferently towards all ſides; and how the deſcending Drops all fall into the Bottle underneath. And if you throw any thing to your Friend, you need uſe no more force one way than another, provided the Diſtances be equal. And if you leap, you will reach as far one way as the other. Having obſerved theſe particulars whilſt the Ship lies ſtill, make the Ship to ſail with what Velocity you pleaſe, and ſo long as the Motion is uniform, not fluctuating this way and that way, you ſhall not per-

ceive there is any alteration in the aforeſaid effects; neither can you from them conclude whether the Ship moveth or ſtandeth ſtill. But in leaping, you ſhall reach as far on the floor as you did before; nor by reaſon of the Ship's motion, ſhall you make a longer Leap towards the Poop than the Prow, notwithſtanding that whilſt you were up in the air, the Floor under your feet had run the contrary way to your Leap. And if you caſt any thing to your companion, you need uſe no more ſtrength to make it reach him, if he ſhould be towards the Prow, and you towards the Poop, than if you ſtood in a contrary poſition. The Drops ſhall all fall into the lower Bottle, and not one towards the Poop, although the Ship ſhall have run many feet, whilſt the Drop was in the air. The Fiſhes in the Water ſhall have no more trouble in ſwimming towards the forepart of the Tub, than towards the hinder part, but ſhall make towards the Bait with equal Swiftneſs, on any ſide of the Tub. And

laſtly

lastly the Gnats and Flies shall continue their flight indifferently towards all parts, and never be driven together towards the side of the Cabin next the Prow, as if wearied with following the swift motion of the Ship. And if by burning a few grains of Incense, you make a little Smoak, you shall perceive it to ascend on high, and hang like a Cloud, moving indifferently this way and that, without any inclination to one side more than another. The cause of which correspondence of the Effects, is, that the Ship's motion is common to all things contained in it, and to the Air also: I mean when those things are shut up in the Cabin: but when they are above Deck in the open Air, and not obliged to follow the Ship's course, differences more or less may arise among the forenamed Effects.

THUS *Galilæo* by this one Observation hath answered the most considerable Objections deduced from Philosophy against the Motion of the

Earth. And thus much ſhall ſuffice for the Explication and Proof of the *Copernican Syſteme*, eſpecially that part of it relating to the *Solar Syſteme*. Which things I have more largely than ordinary inſiſted on, for the ſatisfaction of many that I am ſenſible doubt of them, and particularly ſome of my Friends (and thoſe not unlearned too) who may be apt to read my following Book with prejudice whereſoever I favour the *Copernican* Notions.

Of the New Syſteme.

And now I paſs from the Second Syſteme to the Third, which is called the *New Syſteme*; which extends the Univerſe to a far more immenſe compaſs, than any of the other Syſtemes do, even to an indefinite Space; and repleniſhes it with a far more grand Retinue than ever was before aſcribed unto it. This

THIS *New Syſteme* is the ſame with the *Copernican*, as to the Syſteme of the Sun and its Planets; as may be ſeen by the Scheme of it in Fig. 3. But then whereas the *Copernican* Hypotheſis ſuppoſeth the Firmament of the Fixt Stars to be the Bounds of the Univerſe, and to be placed at equal Diſtance from its Center the Sun; the *New Syſteme* ſuppoſeth there are many other Syſtemes of *Suns* and *Planets*, beſides that in which we have our reſidence: namely, that every Fixt Star is a Sun, and encompaſſed with a Syſteme of Planets, both Primary and Secondary, as well as ours.

THESE ſeveral Syſtemes of the Fixt Stars, as they are at a great and ſufficient diſtance from the Sun and us; ſo they are imagined to be at as due and regular diſtances from one another. By which means it is, that thoſe multitudes of Fixt Stars appear

to

to us of different Magnitudes, the neareſt to us large; thoſe farther, and farther leſs and leſs.

Of thoſe Syſtemes of the Fixt Stars I have given a rude repreſentation in Fig. 3. together with that of the Sun; which may ſerve to give an unskilful Reader ſome conception of the ſtate of the Univerſe, altho' there be but little likeneſs in it, for want of room to lay out all the ſeveral Syſtemes in due proportion; which is neceſſary to a true repreſentation of the matter.

In this 3d Fig. the Fixt Stars with their Syſtemes (repreſented by little Circles about thoſe Stars, which Circles ſignify the Orbits of their reſpective Planets) are placed without the limits of the Solar Syſteme, and the Solar Syſteme is ſet in the Center of the Univerſe, and figured as a more grand and magnificent part thereof. And ſo it may be looked upon by us,

by

by reaſon of its proximity and relation to us. But whether it be really ſo, whether it be in the Center of the Univerſe, and whether among all the noble Train of Fixt Stars, there be no Syſteme exceeding ours in its magnificent Retinue of Planets both Primary and Secondary, and other admirable Contrivances, is a difficulty as out of the reach of our Glaſſes, ſo conſequently above our ability to fathom, although not at all improbable. But be the various Syſtemes of the Univerſe as they will as to their Dignity, it is ſufficient that in all probability there are many of them, even as many as there are Fixt Stars, which are without number.

THIS *Syſteme* of the *Univerſe*, as it is phyſically demonſtrable, ſo is what, for the moſt part, I have followed in the enſuing Book, but not ſo rigorouſly and obſtinately, as utterly to exclude or oppugne any other Sy-

Syſteme, becauſe as the *Works of GOD* are truly great, and ſufficiently manifeſt their excellence and magnificence in any Syſteme; ſo I was willing to ſhew the ſame in ſuch Syſtemes as I had occaſion to ſpeak of them in; becauſe I would not offend, and conſequently not bar the force of my arguments upon ſuch Readers, as might happen to be wedded to the *Ariſtotelian Principles*, or prejudiced to the *Ptolemaick*, or any other *Syſteme*: not that I had my ſelf any doubts about this *New Syſteme*, but think it to be far the moſt rational and probable of any, for theſe reaſons.

1. Becauſe it is far the moſt magnificent of any; and worthy of an infinite CREATOR: whoſe *Power* and *Wiſdom* as they are without bounds and meaſure, ſo may in all probability exert themſelves in the Creation of many Syſtemes, as well as one. And as Myriads of Syſtemes

are

are more for the *Glory* of GOD, and more demonſtrate his *Attributes* than one, ſo it is no leſs probable than poſſible, there may be many beſides this which we have the privilege of living in. But it is very highly probable the matter is ſo, by reaſon

2. We ſee it is really ſo, as far as it is poſſible it can be diſcerned by us, at ſuch immenſe diſtances as thoſe Syſtemes of the Fixt Stars are from us. Our Glaſſes are indeed too weak ſo to reach thoſe Syſtemes, as to give us any aſſurance of our ſeeing the Planets themſelves, that encompaſs any of the Fixt Stars. We cannot ſay we ſee them actually moving round their reſpective Suns or Stars. But this we can diſcern, *viz.* That the Fixt Stars have the Nature of Suns, as I have made probable in Book 2. Chap. 2. As alſo that there are ſomething very like unto Planets, which ſometimes

appear and diſappear in the regions of the Fixt Stars; as I have ſhewn in my diſcourſe of *New Stars*, Book 2. Chap. 3.

But beſides what I have ſaid there, I have this farther to add from ſome late obſervations I have made ſince my writing that part of my Book; and that is, That the *Galaxy* being well known to be the fertile place of *New Stars*, the region in which they commonly appear, I am much inclined to be of opinion; that the *Whiteneſs* there is not cauſed by the bare Light of the great number of Fixt Stars in that place, as hath commonly been thought, but partly by their Light, and partly (if not chiefly) by the Reflections of their Planets; which ſtop and reflect, intermix and blend the Light of their reſpective Stars or Suns, and ſo cauſe that Whiteneſs the *Galaxy* preſents us with; which hath rather the colour of the Reflected

Light

Light of our Moon, than the Primary Light of our Sun.

And that there are Planets enough for this purpose, I suspect, because I have some reasons to imagine that there are many more *New Stars* in the *Milky Way* (all which I take to be a kind of Planetary Globes) than have ever yet been taken notice of, and that many of those prodigious numbers of Telescopical Stars visible there, are of the numbers of New Stars or Planets, and not of Fixt Stars only. This Suspicion I have for some time had, but especially lately from my Views of the *New Star* that now begins to disappear in the *Swan's Neck*. Which gave me occasion to inspect some other parts of that Constellation, most parts of which are well replenished with a numerous train of small Stars. Amongst which, sometimes methoughts more have presented themselves through one and the

ſame Glaſs, and ſometimes I have miſt ſome I thought I before ſaw: and ſometimes alſo methoughes I have ſeen them nearer to, and ſometimes farther off thoſe Stars that did conſtantly preſent themſelves. But as theſe things are to my ſelf novel, and what I confeſs I have rather Suſpicions of than Certainty, I ſhall refer them to the future Obſervations of my ſelf, and others, for their Confirmation; eſpecially becauſe thoſe Approximations and Receſſes of ſome of the little Stars I ſpake of, ſuit not with the Obſervations of ſome very eminent Aſtronomers.

THESE Obſervations as they will open to us a New, and admirable Scene of the Heavens (if it be as I imagine) ſo I earneſtly recommended the Enquiry into it to ſuch as delight in thoſe matters. For the doing of which, I conceive it may be ſufficient, and the eaſieſt courſe, to make the

the Obſervations in ſome one part of the Milky-Way, as in ſome part of the *Swan*, as much or a little more than falleth within the Compaſs of the Teleſcope you make uſe of, which was the way I practiſed, and that part of the Heavens, in which I obſerved. All the Stars that fall within this Area, an exact Map muſt be taken of, which will ſhew when any Variations happen. And for taking in the larger Area of the Heavens, a Glaſs of 6 or 8 feet is ſufficient, and rather better for the purpoſe than longer Glaſſes, which take in leſs, and are more troubleſome in uſing.

HAVING thus repreſented the State of the *Univerſe* according to the *New Syſteme* of it, the uſual Queſtion is, what is the uſe of ſo many Planets as we ſee about the Sun, and ſo many as are imagined to be about the Fixt Stars? To which the anſwer is, That they are *Worlds*, or places

of *Habitation*, which is concluded from their being *habitable*, and well provided for Habitation. This is pretty manifeſt in our Solar Planets, from their being opake Bodies as our Earth is, conſiſting in all probability of Land and Waters, Hills and Valleys, having Atmoſpheres about them, Moons miniſtering unto them, and being enlightened, warmed and influenced by the Sun, whoſe yearly Viſits they receive for Seaſons, and frequent Returns for Days and Nights. All which particulars are fully treated of in the following Book, and need not therefore to be anticipated here. Only there is one thing, which for want of ſufficient Obſervations, I could not ſo fully ſpeak of as I would; and that is concerning the *Seas in the Moon*, in Book 5. Ch. 4. Note 1. whoſe very exiſtence Mr. *Huygens* (11) denies, ſaying, *Marium vero ſi-*

(11) Coſmotheoros. p. 114.

mili-

militudinem illic nullam reperio, &c. i. e. In the Moon *I find no likeness of Seas*, although Kepler and most others are of a different opinion. *For those vast plane regions, which are much darker than the Mountainous parts, and are commonly taken for Seas, and bear the names of Oceans; in those very places viewed with a long Telescope, I find little round Cavities, with shadows falling within them; which cannot agree with the Surface of the Sea: as also those very large Fields, when carefully viewed, do not present us with a Superficies altogether equal. Wherefore these cannot be Seas, but are such places as consist of a less bright matter than that which is in the more hilly parts, but in which also there are some places brighter than others.* Thus the most ingenious Mr. *Huygens*, who then proceeds to shew that there are neither Rivers, Clouds, Air, or Vapours.

But that there are Seas, or great Collections of Waters, and consequently

quently Rivers, Clouds, Air and Vapours in the Moon, I ſhall make out from ſome of my own Views and Obſervations; many of which were made with Mr. *Huygens*'s own long Glaſs before mentioned; through which, and all other long Glaſſes, inſtead of imagining the Lunar Spots to be unlike Seas, I have always thought them to look more like Seas, than through ſhort Glaſſes.

It is true indeed that in thoſe Spots we take to be the Seas, there are ſuch Cavities as Mr. *Huygens* ſpeaks of, or rather Mountains with ſhaded Cavities in them, as alſo ſome parts leſs dark than others. Thus in the Southerly parts of the *Lunar Euxine* and *Mediterranean*, in the *Sinus Sirbonis*, the *Egyptian*, and divers other Seas, there are ſeveral ſuch parts that appear more luminous than others, ſome having the appearance of Rocks and Iſlands, ſome of large Shallows, parti-

particularly towards the Shores, and especially in the Seas bordering on the Continents, such as the great Southern Continent of the *Lunar Ægypt* and *Palestine*. But this is no conclusive argument of those parts not being Seas; because they may be Seas having many Islands and Shallows in them. But then in other parts, and even in some parts of these last named, the Spots appear darker, and with but few of those Eminences or Islands, those brighter or shallow parts. Thus the Northerly *Euxine*, and *Mediterranean*, the *Palus Mœotis*, and many other of those Lunar Seas; few of those parts that have the aspect of Islands or Shallows are to be discerned in them, only one here, and another there, at considerable distances from one another.

And in this very manner I doubt not our terraqueous Globe would appear, if viewed at the Moon, or

makes a pretty shew in the Telescope.

And now considering how accomplished the Moon, and all the other Planets are for Habitation, how solemn an Apparatus is in them for this service: and considering also that these Accoutrements relate to their respective Planets only, and in all probability are of little or no use to our Earth; with great reason therefore the Maintainers of the new Systeme conclude those Planets, yea all the Planets of the Sun and of the Fixt Stars also to be *habitable Worlds*; places as accommodated for Habitation, so stocked with proper Inhabitants.

But now the next Question commonly put is what Creatures are they inhabited with? But this is a difficulty not to be resolved without a Revelation, or far better Instruments than the World hath hitherto been acquainted with. But if the Reader should have a mind to amuse himself

ſelf with probable Gueſſes about the Furniture of the Planets of our Solar Syſteme, what Countries 'tis probable are there, what Vegetables are produced, what Minerals and Metals are afforded, what Animals live there, what Parts, Faculties and Endowments they have, with much more to the ſame purpoſe; he may find a pleaſant entertainment enough in the great *Mr. Chriſtian Huygens*'s *Coſmotheoros*. To which I ſhall refer him, rather than give either him or my ſelf any farther trouble about theſe matters, which are meerly conjectural.

Thus having, for the ſake of the Unskilful Reader, given an account of the three *Syſtemes* principally concerned in the following Book, and having alſo for the ſake of the Doubting Reader, inſiſted more largely than ordinary upon the two laſt of thoſe Syſtemes, little remaineth for the putting an end to this long Preface

face, but to make my Excuſe (if it needs any) for aſſigning the Diameters and Diſtances of the Heavenly Bodies in Engliſh miles, rather than other larger Meaſures, which would perhaps have come nearer the truth. But this was alſo for the ſake of ſuch as are not very converſant in Aſtronomical Matters and Dimenſions, who can better underſtand you, when you ſay, It is ſo many miles, than ſo many Degrees, Minutes, or Seconds, or Semidiameters of the Earth or other Planets.

And now for a Concluſion, I ſhall only intreat all my Readers to joyn with me in their earneſt Prayers, that as this Work is deſigned for the good of Mankind, particularly for the Conviction of Infidels, for the Promotion of the Fear and Honour of GOD, and the cultivating of true Religion, ſo it may have its deſired Effect.

W. Derham.

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A SURVEY OF THE HEAVENS.

The Introduction.

THE *Pſalmiſt* ſaith, (1) *The Heavens declare the Glory of* GOD; *and the Firmament, ſheweth*, publickly declareth, telleth forth, or preacheth *his Handy-Work*, as the Hebrew Word ſignifies

(1) Pſal. 19. 1, 2, 3.

(1): that *Day unto Day uttereth Speech, and Night unto Night ſheweth*, or tells forth, *Knowledge*. Which Language of the Heavens is ſo plain, and their Characters ſo legible, that all, even the moſt barbarous Nations, that have no Skill either in Languages or Letters, are able to underſtand and read what they proclaim. *There is no Speech nor Language where their Voice is not heard: their Line is gone out through all the Earth, and their Words to the End of the World.*

THAT this Obſervation of the *Pſalmiſt* is agreeable to Experience, is manifeſt from the Deductions which all Nations have made from God's Works, particularly from thoſe of the Heavens; namely, that there is a GOD; and that ſuch as

(1) נגד *ſignificat aliquid verbis efferre, coràm nuntiare, annunciare*, Conrad. Kircher. Concord. Col. 226. Vol. 2. It is derived from נגד *Coràm, Ante.*

have pretended to Atheiſm, and have deduced God's Works from Chance, *&c.* are ſingular and monſtrous in their Opinions. Thus ſaith *Ælian* (1), *There never was any Barbarian that contemned the Deity, nor called in queſtion whether there be any Gods or no? or whether they take care of human Affairs? No Man, neither* Indian, *nor* Celt, *nor* Ægyptian *ever entertained any ſuch Thought as* Eumerus *the* Meſſenian, *or* Dionyſius *the* Phrygian, *or* Hippo, *or* Diagoras, *or* Socias *or* Epicurus. So one of *Plato's* Arguments for the Proof of a God, is (2) *The unanimous Conſent of all, both* Greeks *and* Barbarians, *who confeſs there are Gods.* And *Plutarch* (3) agreeable to what our *Pſalmiſt* affirms, tells us whence they collected this Knowledge of a Deity. *Men*, ſaith he, *began to ac-*

(1) De var. Hiſt. L. 2. cap. 31.
(2) De Legibus. L. 10.
(3) De Placit. Philoſ. L. 1. c. 6.

knowledge a God; when they ſaw the Stars maintain ſo great a Harmony, and the Days and Nights through all the Year, *both in Summer and Winter to obſerve their ſtated Riſings and Settings:* And to paſs over a great deal of this kind, that I could cite from divers Heathen Authors, *What,* ſaith the *Stoick* in *Tully,* (1) *can be ſo plain and clear, as when we behold the Heavens, and view the Heavenly Bodies, that* we ſhould conclude *there is ſome Deity of a moſt excellent Mind, by which theſe things are governed?*------*A Preſent and Almighty God. Which he that doubts of, I do not underſtand,* ſaith he, *why he ſhould not as well doubt whether there be a Sun or no* that ſhines. And then he goes on to prove that this can be no idle Fancy depending on the Caprice

(1) *Quid enim poteſt eſſe tam apertum, tamque perſpicuum, cum Cælum ſuſpeximus,* &c. De Nat. Deor. L. 2. c. 2.

of

of Man, but a well grounded, ſubſtantial Opinion, bearing the Teſt of Ages and confirmed by the Length of Time. *For*, ſaith he, *Time wears out the Figments of Opinions, but confirms the Judgments of Nature*; or ſuch Notions as are grounded upon the true Judgment and Nature of Things. *For which reaſon*, ſaith he, *both among our ſelves, and in other Nations, the Veneration of the Gods, and the Sacredneſs of Religion augment and improve every Day more and more.*

Thus *the Heavens declare the Glory of God*, even to the Heathen World, ſo manifeſtly are they the Handy-Work of God. And that they are his Work, will appear by taking a View of theſe Seven Particulars.

1. The Magnitude of the Heavens.

2. The great Number of the Heavenly Bodies.

3. Their Diſtances.

4. Their Motions.
5. Their Figures.
6. Their Gravity.
7. Their Light and Heat, and the admirable Proviſions made for thoſe Benefits.

BOOK

BOOK I.

OF THE *MAGNITUDE* OF THE UNIVERSE, and the *BODIES* therein contained.

CHAP. I.

The Ancient and Modern Reckonings compared.

BEFORE the Invention of the Teleſcope, the Univerſe was thought to be confined within far more narrow Bounds than it is ſince found

found to be, the fixt Stars being imagined to be all placed in the Starry Heavens (which they called the *Firmament*) at equal Diſtances from the Earth (the Center) like ſo many golden Nails driven in the Top of ſome arched Roof, or other circular Concave, encompaſſing our Eye. Theſe, although far more narrow Bounds, and a more ſcanty Reckoning than it ſhould be, yet was ſufficient to ſhew who was the Maker of ſuch a ſtupendous Arch, and ſo noble a Train as is contained therein.

But according to the modern Reckoning (which is far the moſt rational, and grounded upon better Phænomena) we ſhall find this Branch of the Creation far more magnificent, and worthy of its infinite CREATOR than thoſe former Computations made it.

And how grand and magnificent a Structure the Heavens are, will appear by a diſtinct Conſideration of the Magnitude of the Heavenly Bodies themſelves; and of the Space in which they are.

Chap. II.

The MAGNITUDE *of the* Heavenly Bodies.

Although we are not able to give a certain Determination of the Magnitude of the Heavenly Bodies, by reaſon of their vaſt Diſtances, yet enough we know, and are ſure of concerning their immenſe Magnitudes, to convince any one that they are the Works of GOD. But to come to Particulars.

The

THE Measure by which we usually gage and compare the Heavenly Bodies, is our Terraqueous Globe; of whose Dimensions and Bulk we can make a pretty good Estimate, having tolerably good and accurate Observations leading us thereto: the Particulars of which I have had Occasion elsewhere to specify (1).

BY these Observations it appears that the Diameter of this our Globe is above 79 Hundred Miles; that

(1) *Physico-Theol.* B. 2. ch. 2. In which Place I have made use of Mr. *Picart's* Measure of the Earth. But notwithstanding the Difference be but small, *viz.* a little above 32 Miles in the whole Diameter of our Globe, yet I shall make use here of our Mr. *Norwood's* and Monsr. *Cassini's* Measures, because they agree to almost a Nicety, and Mr. *Cassini's* were made (by the King's Command) at greater Distances, with the greatest Accuracy. And according to these Measures, the Diameter of the Earth is 7967.7 English Miles, its Surface 199441201 Miles, and its Solid Content 264856000000 Miles.

con-

conſequently its Surface is a good deal above 199 Millions of Miles, and its ſolid Content or Bulk near 265 Thouſand Millions of Miles. If therefore we ſhould go no farther from Home than our own Globe, a Maſs we here have worthy of an Infinite Creator, a Work proclaiming that great Being that made it.

But as vaſt a Body as this ſeems to be, it is much leſs than many, yea moſt of the Heavenly Bodies that are viſible to us, except two or three of the Planets, which ſeem to be leſs than our Globe, namely *Mars*, whoſe Diameter is reckoned to be but 4875 Engliſh Miles; and the *Moon*, whoſe Diameter is but 2175 Miles; and *Mercury*, whoſe Diameter is 2748 Miles (1); but yet theſe vaſt and a-

(1) The Number of Miles which I have here, and all along, aſſigned to the Diameters of the ſeveral Planets are the mean Numbers between Mr. *Flamſteed*'s in Mr. *Whiſton*'s *Aſtro-*

mazing

mazing Bodies too. But for the reſt, there is good Reaſon to imagine their Bulk exceeds that of our Terraqueous Globe. Thus the two ſuperiour Planets by far exceed us; *Saturn* being computed at 93451 Miles in Diameter, and conſequently at

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nomical Lectures, and Mr. *Huygens*'s in his *Syſt. Saturni*. and *Coſmotheor.* which (as Mr. *Whiſton* firſt ſuggeſted to me) ſeem to be neareſt the Truth. For whereas the Rays of Light when intercepted by the Edge of a Knife or other Body, are as Sir *Iſaac Newton* obſerves in his *Princip.* L. 1. Prop. 96) ſomewhat bent, as if attracted from a ſtrait Line by that Body; and whereas Mr. *Flamſteed*'s Meaſures were taken with a Micrometer that pinches or claſps the oppoſite Edges of a Planet which would incurvate the Rays one Way; and Mr. *Huygens*'s were taken with the Interpoſition of a thin tapering Plate covering the Planet as far as the extremity of its Face, which would cauſe an Incurvation of the Rays the contrary way; therefore Mr. *Flamſteed*'s Meaſures are as much too little, as Mr. *Huygens*'s are too large, and conſequently the Mean between them probably neareſt the Truth.

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427318300000000 Miles in its Bulk; and *Jupiter* at 120653 Miles in Diameter, and 92001120000000 Miles in Bulk. But yet as amazing Maſſes as theſe all are, yet they are all far out done by that ſtupendous Globe of Fire, the *Sun*; which as it is the Fountain of Light and Heat to all the Planets about it, affording them by his benign Rays, and kindly Influence, the great Pleaſures and Comforts of Life; ſo doth it as far ſurpaſs them in its Bulk; its apparent Diameter being computed at 822148 Engliſh Miles, and its ſolid Content at 290971000000000000 Miles, ſuppoſing the Face we ſee of the Sun to be its true and real Globe.

THUS ſtupendous are the Magnitudes of the Globes of this our *Solar Syſteme*. But theſe not all, nor perhaps the moſt conſiderable Bodies of the Univerſe. For the fixt Stars, although in Appearance but ſo ma-

ny golden or flaming Spots, yet are, with great probability, ſuppoſed to be ſo many Suns, ſurrounded with their reſpective Syſtemes of Planets, as our Sun is; and no leſs in Magnitude, if not greater, (ſome of them at leaſt) than our Sun is, but only diminiſhed in Appearance by their prodigious Diſtances from us.

If now we reflect upon the prodigious Maſſes of thoſe many Heavenly Bodies that preſent themſelves to our View, and many more I ſhall ſhew are unſeen; what a ſurprizing Scene do the Heavens afford us of the great CREATOR's Power! a Train of ſuch immenſe Bodies, that what leſs than an Almighty Hand could firſt find Matter ſufficient for, and then compoſe ſuch Magnificent Works! But yet what is the Magnitude of all theſe Bodies to that immenſe Space in which they are? Which is the next thing to be conſidered.

CHAP.

CHAP. III.

Of the IMMENSITY *of the Heavens.*

IT is neceſſary that I ſhould give a diſtinct conſideration to the immenſe Space poſſeſt by the Heavenly Bodies, becauſe it was once imagined to be limited by the narrower Bounds of the *Ptolemaick Syſteme*, by that which they called the Ἀπλανὲς, the *Starry Concameration*, or *Firmament* of the fixt Stars, as I have before intimated; but now with far greater Probability and Reaſon it is extended to an indefinitely larger Space, a Space ſufficient, without all doubt, to contain all the noble Variety of Syſtemes therein, not only our own of the Sun, but all thoſe others I mentioned of the fixt Stars alſo. But for

for the better proof, and more eaſy Apprehenſion of the Magnitude of this vaſt expanded Space, let it be conſidered,

1. THAT ſome, if not every one, of thoſe vaſt Globes of the Univerſe hath a Motion. This is, in ſome, manifeſt to our Sight, and may eaſily be concluded of all, from the conſtant Similitude and Conſent that the Works of Nature have with one another. But in what manner theſe Motions are performed, whether by the Motion of the Heavenly Bodies round the Earth, or by the Earth round its own Axis, or any other way, it matters not much now to enquire.

2. IT is manifeſt that the Earth is ſet at ſuch a due Diſtance from the Heavenly Bodies, and the Heavenly Bodies at ſuch a due Diſtance from one another, as not to interfere, claſh with, or diſorder one another,

Nay

Nay ſo great is their Diſtance, ſo convenient their Situation, that they do not ſo much as eclipſe one another, except ſuch Planets as are called Secondary.

3. It is farther manifeſt alſo, That thoſe vaſt Bodies are ſo far off, as to appear extreamly ſmall to our Eye, conſidering their prodigious Magnitudes.

Now for the effecting of this, or any of the other Matters, it is neceſſary that there be a ſufficient Space. And that there is ſuch, and what that Space is, we may make a Judgment of, by conſidering Particulars according to the beſt Obſervations we have of theſe things.

And to begin neareſt Home; the neareſt of the Heavenly Bodies to us is the *Moon*, whoſe Orb is the leaſt of any of the Celeſtial Globes, but yet ſhe takes up a Space of near 480

thouſand *Engliſh* Miles in Breadth (1) to perform her monthly Revolution in. And as for the Earth, if with the Moderns, we ſuppoſe it, together with it's Satellite the Moon, to revolve round the Sun; or (which amounts to the ſame thing) if the Sun revolves round the Earth, this *Magnus Orbis*, as it is uſually called, is a Space of above 540 Millions of Miles Circumference (2), or 172

(1) The Moon's *mean Diſtance* from the Earth according to Sir *Iſaac Newton's Princip.* p. 430. is 60 ½ Semidiameters of the Earth, according to which, the Diameter of the Moon's Orbit is 479905 *Engliſh* Miles.

(2) Concerning the Diſtance between the Sun and the Earth, there is a great Diſagreement between the former and latter Aſtronomers, occaſion'd by the Diſagreement between their Obſervations of the Sun's *Horizontal Parallax* (which is equal to the Earth's Semidiameter viewed at the Sun) *Tycho* making it 3 minutes, *Kepler* but one, *Bullialdus* 2 minutes, 21 ſeconds, and *Riccioli* but 28 ſeconds. Conſequently the Diſtances ariſing from hence

Millions of Miles Breadth. And if to that we add the Increment cauſed by the Sweep of the Moon, or the

are leſs than thoſe of the latter Aſtronomers. The very ingenious and accurate Monſ. *de La Hire* in his *Tabul. Aſtron.* thinks the Sun's Horizontal Parallax to be not above 6 Seconds, and his Diſtance therefore to be 34377 Semidiameters of the Earth. But although his Obſervations were made ſince, yet I ſhall make uſe of Monſ. *Caſſini*'s Number, being deduced from very ingenious and accurate Obſervations of the Parallax of *Mars*, and agreeing nearly with the Determination of two great Men, Mr. *Flamſteed* and Mr. *Huygens*, and I may add Dr. *Halley* too, who make it about 10 or 12000 Diameters of the Earth. That great Aſtronomer aſſigns a Number between them, in his *Les Elemens de L'Aſtron.* § 37. *That the Sun's Parallax being ſuppoſed to be* 9 ½ *Seconds, gives the Diſtance of the Sun from the Earth* 21600 *Semidiameters of the Earth:* which are equal to 86051398 *Engliſh* Miles. And imagining the *Magnus Orbis* to be a Circle (which is an Ellipſis not much differing from a Circle) the double of that Number is the length of its Diameter, *viz.* 172102795 *Engliſh* Miles.

Theſe Numbers are different from thoſe I have aſſigned in my *Phyſico-Theol.* B. I. ch. 4. Note 5. from a Miſtake at that time.

Excurſion of her Orb beyond the *Magnus Orbis*, we ſhall have a Space yet broader by near 280 thouſand Miles. But as vaſt a Space as this ſeems to be, yet it is not ſuch as to cauſe either the Earth or Moon to claſh with any of the other Celeſtial Globes, as I have ſaid; nay ſo far from that, that not ſo much as their Shade approaches any of them. In which caſe, what ample Orbs muſt the three Superior Planets have? what a Space is neceſſary for them and their more numerous Moons to perform their much larger Courſes in? And accordingly ſuch Spaces they, and the reſt of the Planets are all found to have: *Saturn* an Orb of 1641526386 *Engliſh* Miles Diameter; *Jupiter* an Orb of 895134000 mil. *Mars* of 262282910 Miles; *Venus* of 124487114 Miles; and *Mercury* an Orb of 66621000 *Engliſh*

Engliſh Miles (3): all of them Spaces ſo accurately laid out, and Diſtances ſo duly proportioned to their Revolutions about the Sun, that abundantly manifeſt infinite Wiſdom to have been concerned in their Appointment, as I intend to ſhew in proper Place.

BUT now after this Account of this ſo prodigious a Space as that of our *Solar Syſtem* is, what is it to the nearly infinite *Expanſum* occupied by the reſt of the Heavenly Bodies! Of which we may have a faint Adumbration by conſidering the Diſtances which, with the greateſt Probability of Obſervation and Reaſon, are aſſigned to the *Fixt Stars*. In order

(3) Theſe Numbers are deduced from the Diſtance between the Sun and Earth, aſſigned in the preceeding Note, and Sir *Iſaac Newton*'s Diſtances of the Planets from the Sun computed from their Periods in his *Principia*, L. 3, *Phænom.* 4.

to the making an Eſtimate of which Matter, let it be ſuppoſed (which is uſually allowed) that the Fixt Stars are ſo many Suns; that they are of the ſame, or nearly the ſame Magnitude as our Sun is; and that the Difference of their Magnitudes ariſeth from the Difference of their Diſtances; if ſo, then it will follow, That the fixt Stars are each of them as much farther from us than the Sun, as their apparent Diameters are leſs than that of the Sun (4). And foraſmuch as few of them appear otherwiſe than as Points even through our beſt Teleſcopes, therefore how prodigiouſly farther muſt they needs be from us than the Sun is, to cauſe their Appearance to be ſo very much leſs than the Sun? For an Example, let us take one of the fixt Stars ſuppoſed to be neareſt

(4) Compare the ſagacious Dr. *David Gregory*'s Demonſtration of this in his *Aſtron.* L. 3. Prop. 56, 60, and 61.

to

to us, as being the brighteſt and largeſt, namely *Syrius*. Now this, by accurate Obſervations (5) hath been found to be in Appearance 27664 times leſs than the Sun; and conſequently, by the foregoing Rule, it is ſo many times farther off than the Sun is, which will amount to above 2 Millions of Millions of *Engliſh* Miles. And if ſo, what an immenſurable Space is the Firmament, wherein a great Number of Stars leſſer and leſſer, and conſequently (according to the foregoing Suppoſition) farther and farther off, are ſeen with our naked Eye, and many more diſcovered with our Glaſſes, and ſtill many more and more with better Glaſſes (6), and in all

(5) See Mr. *Huygens* in *Coſmotheor.* p. 137.

(6) In viewing the Planets with my longer Glaſſes, eſpecially the Planets of a weaker Light, it often falls out that divers of the Fixt Stars, and ſome of them very ſmall, preſent

probability many others that eſcape the Reach of our utmoſt Art to deſcry; which may conſequently be as far diſtant from thoſe we ſee, as thoſe are from us.

themſelves at the ſame time within the Glaſs, notwithſtanding its *Area* is not ſufficient to contain both *Jupiter* and his moſt diſtant *Satellites*. By which means it is ſometimes difficult to diſtinguiſh between thoſe Fixt Stars and the Satellites of the Planets. Thus I have ſometimes been ready to fancy that I ſaw one or more Satellites near *Mars*, untill by future Obſervations I perceived they were only ſome of the Teleſcopick fixt Stars lying in the Way of *Mars*. So about *Saturn*, I have only diſcerned the Likeneſs of many Satellites, but I am not ſure I ever ſaw above three. From whence it is manifeſt, that in all Parts of the Heavens there are many Stars which preſent themſelves to our Eye through our long Glaſſes, that are otherwiſe inviſible to us.

CHAP.

CHAP. IV.

Practical Deductions from, and Reflections upon the MAGNITUDE *of the* Heavens.

HAVING ſet forth the prodigious Magnitude of the Heavenly Space, and of the Bodies therein contained, before we proceed farther, let us pauſe a little to conſider what Influence theſe Things ought to have upon us.

AND in ſhort who can behold the Regions above, and conſider the Things therein contained, and at the ſame time not own them to *declare the Glory of God*? Who can view that immenſurable Firmament in which thoſe Bodies are, and not acknowledge his Handy-Work? We admire,

as

as juſtly we may, the vaſt Bulk of this our own Globe; but when we conſider how much it is ſurpaſſed by moſt of the Heavenly Bodies, what a Point it degenerates into, and how little more even it, and what we call its *Great Orb* together alſo, are, when ſeen from the Heavens, this gives us a juſt and noble Idea of the Infinite Creator's Works, ſuch as is worthy of God, and ſuch as may make us ſlight, not overvalue this little Heap on which we dwell, and cauſe our Thoughts and Deſires to ſoar among the Heavenly Glories. But for an Application of theſe Conſiderations, let us hear *Seneca*'s Reflections upon the Matter (7), who on this Account recommends Virtue, not purely *becauſe it is a noble thing in its own Nature, and a great Bleſſing to be free from Evil, but alſo becauſe it enlar-*

(7) Nat. Quæſt. L. 1. Præfat.

geth

geth the Mind, and prepares it for the Knowledge of Heavenly things, and makes it fit to aſſociate with God (8).— *Then,* ſaith he, *the Mind hath the conſummate and full good of our human State, when having conquered all Evil, it ſoars aloft, and wandering among the Stars above, it is able to deride the ſtately Structures of the Wealthy, and all their Riches.* ——— *Neither,* ſaith he, *can it contemn the Porches and Roofs ſhining with Ivory, the clip'd Groves, and the pleaſant Streams conveyed to their Houſes, until it hath wandered throughout the whole World, and from above looking down upon this little Globe, covered in a great meaſure by the Sea, and, where not ſo, ſlovenly, and either burnt up in one part, or frozen in the other, it then ſaith to it ſelf, Is this that little Point that is divided among ſo many Nations by Fire*

(8) *Qui in conſortium D E I veniat.*

and

and Sword? Oh how ridiculous are the Bounds of Mortals, when this River divides this Nation, that Mountain boundeth another, and that Desart another? For as for this World, saith he, *It is but a Point in which ye sail, in which ye war, in which ye dispose of Kingdoms. But above, are vast Spaces, into the Possession whereof the Mind is admitted, on Condition it hath brought but little of the Body along with it, that it hath cleansed itself from every filthy thing, and being disengaged from the World hath made itself illustrious, by being expeditious and light, and content with little things. When such a Mind,* saith he, *hath touched those Celestial Regions, it is then nourished and grows; and, as if delivered from its Bonds, it returns to its original State. And this Argument it hath of its Divinity, that it delights in divine Matters, and is conversant with them, not as things strange, but its own. There it securely beholds*

the

the riſing and ſetting Stars, their different Courſes, &c. There this curious Spectator diſcuſſes every thing, and ſearches out every thing. And indeed what ſhould it do but pry into thoſe Matters, ſince he knows they belong to himſelf. Then he contemns the narrow Bounds of his Habitation in this World. —— And here at laſt he learns what he hath long enquired after: there he begins to know God (9).

(9) *Illic incipit* DEUM *noſſe.*

BOOK II.

THE *Great NUMBER* OF THE Heavenly Bodies.

CHAP. I.

A General View of the NUMBERS of the Heavenly Bodies.

HAVING in the preceding Book given a Demonſtration of God from the *Magnitude* of the Heavenly Bodies, I ſhall do the ſame in

in this from their *Number*; a Number ſo great, that we cannot view and conſider them without Aſtoniſhment. Were there no more of them than the Sun, and the Planets (both Primary and Secondary) ſuppoſed to move about him, there would be a Number ſufficient to manifeſt an Almighty and Wiſe CREATOR: But when we view the Heavens, and ſee ourſelves ſurrounded with ſo prodigious a Number of illuſtrious Bodies, of various Magnitudes; when we go to other Parts of this our Globe, from the Northern, ſuppoſe to the Southern Pole, and there diſcover a great Multitude of other Stars, that were never ſeen in our Hemiſphere: when we perceive the Heavens thick beſet with them in every Place; and when (as I already hinted) we view the Heavens with our Glaſſes, and diſcover many more than our naked Eye could reach; and when we again

view

view them with better and better Inſtruments, and ſtill diſcover more and more of thoſe Starry Globes; when particularly we ſurvey what they call the *Milky-Way*, and ſee the prodigious Number, I may almoſt ſay Cluſters, of Stars, that fill that Region of the Heavens, and cauſe that remarkable whiteneſs there: I ſay, when we ſee ſuch prodigious Numbers of thoſe Heavenly Bodies, which no art of man can number; and when we farther conſider, that in all probability, we do not ſee the half, nay perchance not the thouſandth Part of what the Heavens do contain; as we cannot but be ſtruck with Amazement at ſuch a multitude of GOD's glorious Works, ſo we cannot but own the *great* CREATOR in them; and we are worſe than Men, if we do not give him his due Praiſes.

CHAP.

CHAP. II.

That the Fixt Stars *are* Suns *encompaſſed with Syſtemes of* Planets.

ALTHOUGH the Number of the Erratick and Fixt Heavenly Bodies we ſee, are ſufficient to ſet forth the Exiſtence and Praiſes of their *great* CREATOR, yet there is one thing more that I cannot eaſily paſs over (though it hath only high Probabilities for it) becauſe it gives us a far more noble and agreeable Idea of the Creation, than the World was ever, that we know of, acquainted with before; and that is, That the beſt and moſt learned modern Aſtronomers do generally ſuppoſe the great multitude of Fixt Stars we ſee, or imagine to be in the Uni-

verſe, to be ſo many *Suns*, and each of them encompaſſed with a Syſteme of *Planets* like our Sun.

And that the *Fixt Stars* are *Suns*, or of much the ſame Nature as our Sun, there is great Reaſon to conclude,

1. Because they are Bodies no leſs immenſe (as I have ſaid) than the Sun, but only diminiſhed, in appearance, by their prodigious diſtances from us.

2. Because they ſhine by their own native Light, not by any borrowed from the Sun. For ſo great are their diſtances from the Sun, and from us alſo, that it is not poſſible their Light ſhould be received from the Sun, and reflected to us, as that of the Moon and other Planets is. And withal, ſo brisk and vivid is their Light, and ſo very ſmall their apparent Diameters, when diveſted of their glaring Rays, and made to have

have their true appearance through our Teleſcopes, that no queſtion is to be made, but that they ſhine by their own innate Light, as our Sun doth.

And if the Fixt Stars are ſo many Suns, certainly they miniſter to ſome grand Uſes in the Univerſe, far above what hath uſually been attributed unto them. And what more probable Uſes, than to perform the Office of ſo many Suns? that is, to enlighten and warm as many Syſtemes of Planets; after the manner as our Sun doth the Erraticks encompaſſing it. And that this is the Uſe and Office of the Fixt Stars is probable,

1. Because this is a far more probable and ſuitable uſe for ſo many Suns, ſo many glorious Bodies, than to ſay they were made only to enlighten and influence our leſſer, and I may ſay inferior, Globe; which another Moon or two, or one or

two of thoſe very Suns ſet nearer to us, would have better done, than all the whole train of Heavenly Bodies now doth. But inſtead of this, many of them, nay perhaps the greateſt number of them are at ſuch immenſe diſtances (as ſhall be ſhewn under the next Head) that they are out of the reach of our naked eye. In which caſe, what uſe is it likely ſuch great numbers of ſuch immenſe, unſeen, far diſtant Bodies can be to our World, when there are ſo many already of divers Magnitudes of thoſe that fall under View, that (beſides other much greater Uſes they may do in the Univerſe) do miniſter to our comfort here upon Earth in ſupplying the Abſence of the Sun and Moon by Night.

2. FROM the Parity, and conſtant Uniformity obſervable in all God's Works, we have great Reaſon to conclude that every Fixt Star hath

hath a Syſteme of Planets, as well as the Sun. For it is certain that the Sun is a Fixt Star to the Fixt Stars, as they are to the Sun. And in this caſe, if (as the juſtly renowned Mr. *Chriſtian Huygens* argues) (1) *we ſhould imagine our ſelves to be placed ſomewhere in the Heavenly Regions, as far from the Sun as from the Fixt Stars, we ſhould then perceive no difference between the one or the other. For it would be very unlikely that we ſhould ſee any of the Solar Planets, either by reaſon of the diminiſhing of their light, or becauſe their Orbs would ſink into the ſame lucid Point with that of the Sun. Being then ſo placed, we ſhould imagine all theſe Stars* [both Sun and Fixt Stars] *to be much of the ſame Nature and Kind; and from a view of any one of them nearer to us than the reſt, we ſhould make our judgment of them all. And now being,*

(1) Coſmotheoros, p. 133.

ſaith he, *by the favour of God, admitted ſo near one of them, namely the Sun, as to ſee ſix leſſer Globes revolving round about him, and other Secondary ones revolving round ſome of them: why ought we not to have the ſame judgment of the reſt of thoſe Suns, as of this, and think it altogether probable that this is not the only Star of all the number that is encompaſſed with ſuch a train, or in any reſpect excels the reſt? Neither alſo that this Star alone revolves round its own Axis, but rather that all the reſt have ſomewhat of the ſame kind alſo.* And ſo that learned Perſon goes on in the further purſuit of his ingenious Argument.

3. BESIDES thoſe ſtrong probabilities, we have this farther to recommend thoſe imaginations to us, That this account of the Univerſe is far more magnificent, worthy of, and becoming the infinite CREATOR, than any other of the narrower

Schemes,

Schemes. For here we have the Works of the Creation, not confined to the more ſcanty limits of the Orb, or Arch of the Fixt Stars, or even the larger Space of the *Primum Mobile*, which the Ancients fancied were the utmoſt Bounds of the Univerſe, but they are extended to a far larger, as well as more probable, even an indefinite, Space; as was ſet forth in the firſt Book. Alſo in this Proſpect of the Creation, as the Earth is diſcarded from being the Center of the Univerſe, ſo neither do we make the Uſes and Offices of all the glorious Bodies of the Univerſe to center therein, nay in Man alone, according to the old vulgar Opinion, that *all things were made for Man* (2). But in this our Scheme we have a far more extenſive, grand, and noble View of

(2) See *Phyſico-Theol.* B. 2. c. 6. N. 3.

God's Works: a far greater number of them; not thoſe alone that former Ages ſaw, but multitudes of others that the Teleſcope hath diſcovered ſince; and all theſe far more orderly placed throughout the Heavens, and at duer and more agreeable diſtances, and made to ſerve to much more noble and proper ends: for here we have not one Syſteme of Sun and Planets alone, and one only habitable Globe, but myriads of Syſtemes, and more of habitable Worlds (3), and ſome even in our own Solar Syſteme, as well as thoſe of the Fixt Stars. And conſequently if in the Sun and its Planets, altho' viewed only here upon the Earth at a great Diſtance, we find enough to entertain our Eye, to captivate our Underſtanding, to excite our Admi-

(3) See the Preface.

ration

ration and Praiſes of the infinite CREATOR and Contriver of them; what an Augmentation of theſe Glories ſhall we find in great multitudes of them! in all thoſe Syſtemes of the Fixt Stars throughout the Univerſe, that I have ſpoken of, and ſhall have occaſion to mention again in the next Chapter.

CHAP. III.

Of NEW Stars.

BESIDES the Planets of our Solar Syſteme, and the wonderful number of Fixt Stars, there are ſome others, which are called *New Stars*, which ſometimes appear and diſappear in divers Parts of the Heavens, and will deſerve a place here.

SOME of theſe New Stars have been taken notice of as early as *Hipparchus*'s time, who *ſeeing ſuch a Star, and doubting whether it often happened, and whether the Stars we take to be Fixt were ſo or no*; he therefore (as *Pliny* tells us) (1) *ſet upon numbering the Stars for poſterity*; *a difficult Task*, he ſaith, *even for a God*: *and by proper Inſtruments he marſhalled them in ſuch order, that their Places and Magnitudes might be known*: *by which means it might be eaſily found, not only whether they decayed and periſhed, or were again renewed*; *but alſo whether any of them changed their places, or had any Motion, as alſo whether they increaſed or decreaſed.* Thus *Pliny*.

SINCE which time many other ſuch New Stars have been taken Notice of by others. To paſs by the

(1) Plin. Nat. Hiſt. L. 2. c. 26.

New

New Stars in *Hadrian*'s, *Valentinian*'s, *Honorius*'s and *Otto*'s times, and name only ſuch as have been more lately taken notice of by men of good Judgment in theſe matters; ſuch were thoſe New Stars obſerv'd by *Tycho Brahe*, *David Fabricius*, *Janſon*, *Bayer*, *Kepler*, *Marius*, *Byrgius*, *Holwarda*, *Hevelius*, *Montanari*, *Bullialdus*, *Caſſini*, our Mr. *Flamſteed*, and ſome others (2); to which may be added a *New Star* that appears at this very time I am writing, in the Neck of the *Swan*; the ſame in all probability that hath been ſeen before by

(2) For a Catalogue of theſe and other New Stars, the Conſtellations in which they appeared, and other matters relating to them, I ſhall refer to *Ricciioli*'s *Almageſt.* Lib. 8. ſect. 2. cap. 1. *Hevelii Prodrom.* in his Deſcription of the Comet in 1665. p. 433. the *Appendix* to *Mercator*'s *Aſtron.* and Mr. *Lowthorp*'s *Abridg.* Vol. 1. p. 247.

Mr.

Mr. *Kirch* (3) in 1687, and 1688, and perhaps by *Bayer* long before, as alſo *Hevelius* and others.

Of theſe *New Stars*, there is reaſon to imagine there may be many, by reaſon they are not confined to any one part of the Heavens, but appear and diſappear in divers Conſtellations, and divers parts of thoſe Conſtellations, as in *Caſſiopeia*, the *Swan*, the *Great Bear*, *Andromeda*, *Eridanus*, the *Whale*, the *Ship*, and divers other parts of the Heavens.

(3) In the *Miſcellanea Berolinenſia*, p. 210. Mr. *Kirch* ſaith, he, for ſome time, ſought this Star in vain, but at laſt on 16 *Aug.* 168. he found it with the help of an 8 Foot Tube, but very ſmall, but that it grew bigger and bigger, ſo as on *Oct.* 23. to be ſeen with the naked Eye, until having arrived to its greateſt Magnitude, it again became leſs and leſs, and at laſt inviſible even in a Teleſcope. By frequent Obſervations he diſcovered its Motion to be very regular, and its Period to be 404½ days.

WHAT theſe *New Stars* are, is hard to determine: *Meteors* they cannot be, becauſe they are of a long continuance, and much too far off, for Bodies that emit ſo little light as Meteors do, to be ſeen by us. And as for other Opinions about them, they are too many, and too frivolous (ſome of them) to be named (4), except one or two of the moſt probable. Among which, one is of ſome that think they may be ſuch Stars as have one ſide darker than the other (as one of *Saturn*'s *Satellites* is ſuppoſed to have) and ſo appear only when the bright ſide is turned towards us, and diſappear as the darker takes place. Some think they may be Fixt Stars that expire in Light and Vapours (5),

(4) If the Reader hath a mind to ſee a variety of theſe Opinions, he may find them largely enough handled in *Riccioli*'s *Almageſt. ubi ſupra* c. 17.

(5) This is what Sir *Iſaac Newton* ſurmiſes in his Princip. L. 3. Prop. 42.

and

and are again rekindled, and recruited by the Acceſs of Comets. Others take them to be Comets themſelves. But if I may be admitted to ſpeak my own opinion, I rather take them to be *Erraticks* of ſome kind or other, and that for theſe Reaſons:

1. FROM ſome of them ſeeming to change their Places, and appearing ſometimes farther off, and ſometimes nearer unto other Stars: as I have ſaid in the Preface, *pag.* 48.

2. FROM that Increaſe and Decreaſe of their Light and Magnitudes which is conſtantly obſerved in them: they being at firſt obſcure, and hardly diſcernable, but by degrees growing brighter and brighter, till ſome of them equal the light of *Venus*; and others the light of the Fixt Stars, of the Firſt, Second, and Third Magnitudes: and then again as gradually grow leſs and leſs till they utterly diſappear.

3. FROM

3. FROM their Periodical motion and return after a certain time. This indeed hath not been ſo carefully and judiciouſly taken notice of as it deſerves, or ſo as to bring their Periods under certain determinations; but yet in ſome of *Hevelius*'s and *Caſſini*'s obſervations, it hath been diſcovered that ſome of the ſame Stars have returned, as particularly that in the *Whale*'s *Neck*, and that which now appears in the *Swan*'s *Neck*, which, as I juſt before in *Note* 3. ſaid, hath a Period of 404½ days, according to Mr. *Kirch*'s obſervations.

THESE are my reaſons for ſuſpecting thoſe *New Stars* to be *Erraticks*, rather than *Fixt Stars* either recruited, or having dark and light ſides.

BUT the grand difficulty is, what kind of *Erraticks* they are, whether *Wandering Suns*, or *Planets* (like ours) of

of other Syſtemes? That they ſhould be *Wandering Suns*, is ſomewhat odd to aſſert: and of what uſe they ſhould be, is hard to imagine, ſince there is nothing of this kind in the Univerſe, that we know of, that may aſſiſt our imagination.

And as to the latter opinion, I confeſs I have been much enclined to ſuſpect that they might be Planets revolving round ſuch Suns as caſt a much fiercer, and more vigorous Light than our Sun doth; and that theſe their Planets might be more denſe than ours, and have Surfaces more ſtrongly reflecting light, and perhaps be much larger too. But notwithſtanding that *Planetary Reflected Light* may be ſent to very great diſtances by theſe means, yet without extravagant Suppoſitions of this nature, it may be doubted whether it would reach us, ſo far off as the Fixt Stars are. And beſides this, another

another doubt is, That altho' there are divers Stars near thoſe New Stars, of greater Magnitudes than any of the New Stars are, which I ever yet have had the fortune to ſee, yet I can ſcarce think them big enough, to conclude them to be the Suns about which thoſe New Stars (if Planets) move. And therefore being uncertain what to determine in ſo intricate a matter, I ſhall leave it to future better Obſervations (which the late long dark Weather hath hindered me in the proſecution of) which I hope may afford us ſo good light, as may lead us into a much greater knowledge of thoſe rare Phænomena.

But whatever thoſe New Stars are, they are a farther Demonſtration of GOD's Power and Glory: and that there are many more of the grand Works of the Creation than what our Eyes behold at all, or that we have only now and then a glimpſe

of. But if (as to me it ſeems very probable) they are Planets of other Syſtemes, ſome of thoſe Erraticks revolving round ſome of the Fixt Stars, then do they lay open a ſtill more glorious Scene of GOD's Works, and give us ſuch a repreſentation of the ſtate of the Univerſe, that the World never dreamt of before, and that even Angels themſelves may be amazed at the ſight of.

BOOK

BOOK III.

The DUE *SITUATION* OF THE Heavenly Bodies.

CHAP. I.

Of the due, as well as great, DISTANCE of the Heavenly Bodies.

HAVE before taken notice of the immenſe Diſtance of the Heavenly Bodies, that it is ſuch as makes thoſe vaſt Bodies, the Fixt Stars (no leſs in all probability, as I

ſaid, than the Sun it ſelf) to degenerate into ſo many Points, yea to eſcape our eye; nay more than this, that it cauſeth even our own *Great Orb* which our Earth deſcribes about the Sun, to ſink into almoſt a Point, or at leaſt a Circle of but a few Seconds Diameter. I ſhall therefore ſay no more on that matter. But that which I ſhall ſpeak of in this Book, is the due proportion of the Diſtances of the Heavenly Bodies, that they are not ſet at random, like a Work of Chance, but placed regularly and in due order, according to the beſt methods of Proportion and Contrivance. Which will be manifeſt from the following Chapters, which will ſhew that the Diſtance is ſuch, that none of the Globes interfere with one another: but inſtead of that, are in due and the moſt nice, commodious Proportion.

CHAP.

CHAP. II.

That none of the GLOBES of the Univerſe interfere.

HAD the Univerſe been the Work of Chance, or any thing but a wiſe Architect, there would have been a great many blunders and inconveniencies in the Situation of ſuch a prodigious number of immenſe Globes as the Univerſe doth contain. Some would have been too near, ſome too far off, ſome would have met with, knock'd and ſtop'd one the other, and ſome would have ſo interfered as to have incommoded the other ſome way or other. But inſtead of this, every Globe throughout the whole Creation is, as far as it is poſſible for us to obſerve,

ſet at ſuch a due Diſtance, as not only to avoid all violent Concourſes, but alſo ſo as not to eclipſe or ſhade one the other, wherever it may be prejudicial, or indeed not uſeful and convenient, or ſo as to hinder one anothers kindly Influences, or to prejudice one another by noxious ones. This is very manifeſt in our own Syſteme of the Sun; and becauſe we ſee it not otherwiſe, we may conclude it to be ſo in all; unleſs we ſhould make ſome exception for what is ſuſpected (and indeed only ſuſpected) of *Comets*, which in their approaches towards the Earth, are imagined to cauſe Diſeaſes, Famines, and other ſuch like Judgments of God. But this is only Surmiſe, and what befals the world at other times without the viſible approach of any Comet. But however, ſuppoſing that as Comets move in Orbs very different from thoſe of the other Heavenly Bodies,

ſo

ſo their Effects and Influences may be as different; yet this may be, and no doubt is (becauſe it may be proved) with the concurrence, and by the appointment of the Divine Providence; who, as Governour of the World, might make ſuch noxious Globes for the Executioners of his Juſtice, to affright and chaſtize ſinful men at their approaches to the Earth, (and as ſome have imagined) to be the place of their Habitation and Torment after death. But ſuppoſing it to be ſo, yet herein is a kind Providence manifeſted, That their Returns to the earth are but ſeldom, and their Stays ſhort, and that they take up many years in paſſing the reſt of their Orbs.

And now whether we conſider the due Situation of the greateſt part of the Heavenly Bodies, whereby neither they, nor their influences do interfere; or the more unuſual Poſi-

tion and Motion of Comets, ſtill it appears that a wiſe and careful Architect was the Contriver and Orderer of it all: eſpecially if we joyn what follows in the next Chapter.

CHAP. III.

Of the nice Proportions of the Diſtances of the Heavenly Bodies.

AS it is one great demonſtration of the ingenuity and skill of an Architect to give due Proportions to his Work; ſo we find this to be abundantly manifeſt in all the Bodies of the Univerſe that fall under our cognizance: among which we may diſcern a curious Order, and that due and nice Proportions are ſtrictly obſerved in their Situation.

How

How the Fixt Stars are ſituated in reſpect to one another, is impoſſible for us to determine at ſuch prodigious Diſtances as they are from us; but they look to us, who can have no regular proſpect of their poſitions, as if placed without any Order: like as we ſhould judge of an Army of orderly, well diſciplined Soldiers, at a diſtance, which would appear to us in a confuſed manner, until we came near and had a regular proſpect of them, which we ſhould then find to ſtand well in rank and file. So doubtleſs, if we could have an advantagious proſpect of the Fixt Stars, we ſhould find them very commodiouſly and well ſet in the Firmament in regard of one another. And this we have great reaſon to conclude from the Rules of Parity, from that conſtant Harmony, and Similitude obſervable among all the works of the Creation, which fall under

admire the hand that acteth in them, the Contrivance and Power of an infinite Workman! For where we have ſuch manifeſt ſtrokes of wiſe order, counſel, and management, of the obſervance of Mathematical Proportions, can we conclude there was any thing leſs than Reaſon, Judgment, and Mathematical Skill in the caſe? or that this could be effected by any other Power, but that of an Intelligent Being, who had Wiſdom and Power ſufficient for ſuch a Work: according to the reaſoning of the *Stoick* in *Cicero*, who pleads thus (1): *If thou ſhouldſt ſee a large and fair Houſe, thou couldſt not be brought to imagine that Houſe was built by the Mice and Weeſles, although thou ſhouldſt not ſee the Maſter thereof: ſo* (ſaith he) *wouldſt thou not think thy ſelf very plainly to play*

(1) Cic. de Nat. Deor. L. 2. c. 6.

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the fool, if thou ſhouldſt imagine ſo orderly a frame of the World, ſo great a variety and beauty of Heavenly things, ſo prodigious a quantity and magnitude of Sea and Land, to be thy Houſe, thy Workmanſhip, and not that of the immortal Gods! And ſo when we ſee ſuch good order, ſuch due proportions in this Region of the Univerſe, and have good reaſon to conclude the ſame may be throughout the whole, can we, without great violence to Reaſon, imagine this to be any other than the Work of GOD?

BOOK IV.

OF THE *MOTIONS* OF THE HEAVENS.

CHAP. I.

That the bare MOTION of the Heavens and Earth are a Demonſtration of God.

IN treating concerning the Motion of the Heavenly Bodies, it will be neceſſary to take in that of the Earth too, it

it being not eaſy to ſpeak of one without the other. And here there are two things that are manifeſt Demonſtrations of the preſence and management of GOD, namely, That ſuch Bodies ſhould move at all: and that their Motion is ſo regular.

1. THAT all thoſe vaſt Globes of the Univerſe ſhould have a Motion, muſt of neceſſity be from ſome Being that had Power enough to put them in motion. For as *Lactantius* well argues, (1) *There is indeed a power in the Stars* (and the like may be ſaid of the reſt of the Globes) *of performing their Motions, but that is the Power of God who made and governs all things, not of the Stars themſelves that are moved.* For it is impoſſible for ſuch lifeleſs, dull, unweildy Bodies to move themſelves, but what Motion

(1) Lactant. L. 2. c. 5.

they have; they muſt receive from ſomething elſe able to move them.

Now this ſome will ſay may be effected by the *Vortices* ſurrounding the Sun, the Earth, or other Primary Mover (2); or from a Vectoral Power, or Emanations of the Sun, (3); or other the like Primary Movers carrying about and puſhing on ſuch Bodies as move about 'em. But allowing that it is poſſible it might be ſo, yet ſtill we muſt recur to ſome *Firſt Mover*, ſome *Primary Agent*, who was able to ſet that principal Mover into Motion: and then the caſe amounts to much the ſame, and the Argument hath the ſame force, whether we attribute the Motion of one, or all the ſeveral Globes to the Power of GOD. For in our Solar Sy-

(2) This was *Cartes* his Notion, and of others long before him.

(3) This was *Kepler*'s Scheme.

ſteme,

ſcheme, for inſtance, if it ſhould be thought, that the Six Primary Planets revolving round the Sun, received their motion from his Revolution round his own Axis; yet *let us think* (as *Plato* argues (4) *how it is poſſible for ſo prodigious a Maſs to be carried round for ſo long a time, by any natural cauſe?* For which reaſon (ſaith he) *I aſſert God to be the Cauſe, and that it is impoſſible it ſhould be otherwiſe.* Thus *Plato*: and his Argument is undoubtedly good, ſince, as *Ariſtotle* argues (5), *Every thing that is moved, muſt of neceſſity be moved by ſome other thing; and that thing muſt be moved by ſomething that is moved either by another, or not by another thing. If it be moved by that which is moved by another, we muſt of neceſſity*, ſaith he, *come to ſome Prime Mover, that is not moved by another. For it is impoſſible that what moveth,*

(4) *Plato* in Epiſtolis.
(5) *Ariſtot. Phyſic.* L. 8. c. 5.

and is moved by another, should proceed in Infinitum.

And now therefore, if in our Solar Syſteme, we ſhould imagine the Moon to be wheeled about our Earth, by the Motion and Vectorial Power of the Earth; and the Moons about *Saturn* and *Jupiter*, by the Motion and Vectorial Power of thoſe Planets; and all the Primary Planets to be turned round about the Sun by the Power of the Sun, yet at laſt we muſt find out a Mover of the Sun it ſelf, and thoſe other Primaries: a Cauſe of ſufficient Power to wheel about thoſe prodigious Maſſes, of ſuch vaſt Bulks, as have before been aſſigned to them, and which, beſides their own Weight, are, according to the former Hypotheſes, clogged and encumbered with the *Vis Inertiæ* of all thoſe Planets, whether Primary or Secondary, or both, which they drive round. And if this

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was the caſe, what Power can be found ſufficient for this Work, but but that of the ſame infinite Hand that at firſt gave them Being!

And ſo for all the reſt of the Moving Bodies of the Univerſe, ſuch as Comets, the New Stars before ſpoken of (6), and the ſlow Motion of the Firmament, or Fixt Stars in 25920 (7) Years. This latter I ſhall ſay no more of, becauſe it may not ariſe from any motion of the Firmament it ſelf, but from ſome other

(6) Book II. ch. 3.

(7) *Ptolomy* made this Motion to be one degree in 100 years. But others ſince make it to be more. *Mr. Street*, in his *Caroline Tables*, makes it 1 gr. 20'. *Hevelius* 1 gr. 24'. 46". 50"'. but Mr. *Flamſteed* agrees *Ricciuli*'s numbers to come nearer the truth, *viz.* 1 gr. 23'. 20". in 150 years, or 40" in 1 year. According to which rate the Motion (called the *Platonick year*) is accomplished in 25920 years.

(8) Sir *Iſaac Newton* demonſtrates how this may ariſe from the Sphæroidal Figure of the Earth, *Princip.* L. 3 prop. 21. & L. 1. prop. 66.

cauſe (8). But for Comets what Power but that of the Almighty could give them ſuch prodigious Projections as their Trajectories or Orbs are found to have? Orbs that run into ſuch amazingly long Ellipſes, that 'tis wonderful how their Projectile Force ſhould carry them to ſuch immenſe Diſtances, and their Gravity at the ſame time bring them back, and retain them in their Orbs.

AND ſo for the New Stars, which I have ſaid are ſo many Signals of Planetary Syſtemes diſperſed here and there all over the Univerſe, they are all of them ſo many manifeſtations and demonſtrations of an infinite Being that hath imparted motion unto them: and they are a ſign alſo that there are other Globes, beſides the Sun and its Planets, which are mo-

(8) Corol. 20. See the matter alſo more eaſily demonſtrated in Dr. *Gregory's Aſtron.* L. I. Prop. 64 ving

ving Bodies, even that all the Globes in the Univerſe are ſuch, and conſequently ſo many Proofs of an *Almighty firſt Mover.*

THUS the bare Motions of the Earth, and of the Heavens are ſo many arguments of a Divine Power therein concerned. But we ſhall moreover find an infinitely Wiſe, as well as Almighty Power herein tranſacting, by what follows in the next Chapter.

CHAP. II.

The great REGULARITY of the Motions of every Globe.

HAVING in the preceding Chapter ſhewn that the giving Motion to ſuch immenſe, lifeleſs Globes, is the work of God, we

ſhall find much greater demonſtrations thereof, if we conſider that theſe Motions are not at random, in inconvenient Lines and Orbs, but ſuch, as ſhew wiſe Deſign and Counſel. I ſhall here ſpecifie but two Examples, becauſe I ſhall have occaſion to ſay more of this matter hereafter. One is, That all the *Planets* ſhould (when their Motions were impreſt upon them) have their Directions or Tendencies given, not in Lines tending from the Center to the Circumference, or very Obliquely, but Perpendicular to the *Radii*. The other is, That the Motions and Orbits of the Planets ſhould not interfere with one another, but tend one and the ſame way, from Weſt to Eaſt, and lie in Planes but little inclined to one another, or when inclin'd, that it ſhould be very beneficially ſo, as I ſhall

ſhall hereafter ſhew. Theſe and many other Inſtances, and in a word, that every Planet ſhould have as many, and various Motions, and thoſe as regular, and well contrived and ordered, as the World and its Inhabitants have occaſion for, what could all this be but the Work of a wiſe and kind, as well as omnipotent CREATOR, and ORDERER of the World's Affairs? a Work which is as plain a Signal of GOD, as that of a Clock, or other Machine is of Man. Thus *Tully's Stoick* (1) argues our preſent caſe from the *Shepherd at Actium*, when from the top of an Hill he happened firſt to ſee a Ship ſailing in the Sea, he was for a while in great amazement and ſur-

(1) De Nat. Deor. L. 2. c. 35.

prize to see such a moving Inanimate Body, and could not imagine of what a Nature it was possible it should be, until he perceived, by some tokens, that it was made and managed by Man. *So*, saith he, *the Philosophers ought to have done, if haply they had any doubts at the first view of the World; afterwards when they should behold its determined and equal Motions, and all things managed by established order, and with immutable constancy; they might then understand that there is not only some Inhabiter in this Heavenly, this divine House, but also some Ruler, and Moderater, and in a manner, Architect of so great a Work, so noble a Performance.* This Conclusion is so natural, so cogent, that any thing but stupid prejudiced Blockheads (as those Philosophers were) would have naturally and easily made it. *But now*, saith

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the Stoick (u), *they seem to me not so much as to have any suspicion of the wonderfulness of the things of the Heavens or the Earth.* And great reason the Stoick had for his surmise. For so manifest a Demonstration of a Deity are the Motions of the Heavens and Earth, that if men *do* not see them, it is a sign of great stupidity; and if they *will* not see, and be convinced by them, it is as plain a sign of their prejudice and perverseness; as will farther appear by considering what an incomparable provision is made for the World's good, by the particular Motions which are given to the Earth and Heavens, namely the *Diurnal* and *Periodical* Motions.

(u) Ibid. c. 36.

CHAP.

CHAP. III.

Of the Diurnal MOTION of all the ſeveral Globes.

AS to the *Diurnal Motion*, there is great probability that our Earth, and all the Heavenly Bodies have a Rotation round their ſeveral Axes; not all performed indeed in the ſame ſpace, or length of time, but ſome in longer, ſome in ſhorter times; each Time making what we call a *Day* in thoſe ſeveral Globes, equivalent, although not equal, to the circumvolution of our Earth in 24 hours.

This diurnal Rotation is viſible in many of the Heavenly Globes, and highly probable in our own. In the *Sun* it is very manifeſt from the equable

ble Motion of its Spots, which ſometimes appear on its Disk, and have been obſerved formerly by *Galilæo* (1), *Scheiner* (2), *Tardè* (3), *Malapertius*, *Hevelius* (4) and our Country men

(1) *Galilæus* tells us in the III. Dialogue of his *Syſtem. Mund.* that he was the firſt that diſcovered *Spots on the Sun*, in the year 1610, which he ſhewed the next year to divers great perſons in *Rome*. That *Scheiner* ſent him two Letters by *Velſerus* under the feigned name of *Apelles*, to deſire his opinion of them: that he concluded them to be alterable, contrary to the received Opinion then, of the *Heavens inalterability*, that they were contiguous to the Sun, and that their path over the Sun, ſometimes in a Curve, ſometimes a ſtrait line, argued the Annual Motion of the Earth about the Sun, and not of the Sun about the Earth; with more to the ſame purpoſe, which may be ſeen in the ſagacious Author, in his 1 and 3. Dialogue.

(2) Vid. *Scheiner's* Roſa Urſina.

(3) V. *Tardè's Aſtra Borbonia*, who took 'em to be ſmall Stars interpoſing themſelves between the Sun and us. Of the ſame opinion alſo was *Malapertius*, who gave them the name of *Sydera Auſtriaca*.

(4) See *Hevelius's* opinion of them at large in his *Selenography*, ch. 5. and in the Appendix

Mr.

Mr. *Gaſcoigne* and Mr. *Crabtrie* (5); and ſince them by Mr. *Boyl*, Dr. *Hook*, Dr. *Halley*, Mr. *Flamſteed*, and others in *England*, and by Meſſieurs *Caſſini*, *Picart*, and others abroad (6); and of late by my ſelf and others too. Theſe Spots have manifeſtly a Motion, and the ſame Motion too, as that of a Globe moving round upon its Poles: for we may perceive them

(5) In their Letters (now in my hands) there is an Ingenious Controverſie between thoſe two great Men, Mr. *Gaſcoigne*, the Inventor of the Micrometer, and Mr. *Crabtrie*, concerning the *Solar Spots* that appeared about the year 1640. which Mr. *Gaſcoigne* imagined to be great numbers of ſmall Planets revolving round the Sun, at a ſmall diſtance from him. Mr. *Crabtrie*'s anſwer and opinion may be ſeen in his Letter which is publiſhed with my own obſervations about the *Solar Spots* from 1702 to 1711 in the *Philoſ. Tranſ.* No. 338.

(6) The Obſervations of theſe great Men (which are diſperſed about in *Ph. Tranſ.*) may be ſeen at one view in Mr. *Lowthorp*'s Abridgment, Vol. I. p. 274.

to be perpetually ſhifting their places from the Eaſtern to the Weſtern Limb of the Sun; and in thus doing, their daily Stages and Motion exactly correſpond to the Motion of a Globe; that is, thoſe Stages are ſhorter, and the motion of the Spots ſeemingly ſlower towards the Sun's Limb, but near the Center of the Disk, larger and ſwifter; and all in exact proportion to a double Line of Sines, ~~or a~~ Line of Sines on each Semidiameter of the Disk.

And farther yet, theſe Solar Spots, as they manifeſtly demonſtrate the Sun to be a moving Globe, turning round once in ſomewhat above 25 days, ſo they manifeſt themſelves to be ſomething adhering unto, or nigh the Sun's globous body, by means of the different appearance they have in the different parts and poſitions of the Sun: as in the middle of the Disk, if they are round,

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towards the Limb they become more and more oval or long, just as such a like Spot on a common Globe would appear when it is turned to the side from us.

And lastly, another thing observeable in and from these Spots is, that they describe various Paths or Lines over the Sun, sometimes strait, sometimes curved towards one Pole of the Sun, sometimes towards the other, exactly corresponding to the different Positions of the Earth in respect of the Sun throughout all parts of the year.

Thus in that vast Mass of the Sun we have manifestly such a diurnal Motion as I spake of, or Circumvolution round its Axis; a Motion constant and regular, and doubtless of as great use to some office or other, in some part or other of the Universe, as the Motions of the Earth are to the Inhabitants thereof: and a Moti-

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on therefore this is demonſtrating the concurrence of the Almighty.

NEITHER is it the Sun alone that undergoes a Diurnal rotation, but moſt, if not all the Erraticks about him. *Saturn* indeed is at ſo great a diſtance from us, that we have not been able to perceive whether or no he hath ſuch a Rotation; but as the other Planets have it, and there is full as much occaſion for it in *Saturn* as in them, ſo there is no great doubt to be made, but that he hath ſuch a like Diurnal Motion, accomodated as well to his ſtate, as it is in the Earth and the reſt of the Planets.

SO *Jupiter* is diſcovered to have manifeſtly a Motion round upon its Axis from Eaſt to Weſt, in the ſpace of 9 h. 56', as Monſ. *Caſſini* (7) by

(7) See his Obſervations in the *Memoirs de Mathem. & de Phyſique* for *Jan.* 1692.

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many repeated Obſervations in the year 1665, and other following years firſt found from the Spots obſervable on it; of which there are two kinds, which I my ſelf have often ſeen as well as others before me, a ſhort account of which (although it be a Digreſſion) may not be unacceptable to many Readers. One kind of thoſe *Jovial Spots* is only the ſhadow caſt upon the Planet by the *Satellites* intercepting the Light of the Sun, when they are interpoſed between the *Sun* and *Jupiter*; the other are ſuch as are really in the body of that Planet, after the manner of thoſe we ſee in the Moon, but not permanent as they are. And by the motion of theſe latter Spots it is manifeſt, not only that *Jupiter* revolves round in the time mentioned, but that it is a moving Globe alſo, by reaſon (as was ſaid of the Sun) thoſe Spots move ſwifter, and in larger Stages towards

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the middle, than towards the Limb of *Jupiter*'s Disk. Alſo ſuch Spots as are round about the middle, appearing long or oval towards the Limb or edge of the Disk; as was before obſerved of the Sun's Spots.

As to *Mars* and *Venus*, they are both diſcovered to have Spots, or parts lighter and darker, as well as *Jupiter*, and to have a motion alſo as he hath. Of thoſe Spots in *Mars*, Dr. *Hook* had divers views in the year 1665, which he hath given us Figures of (8): and from thence concluded that Planet had a Motion, although he could not determine in what time it was performed. But Mr. *Huygens* expreſly ſaith (9) it is performed in the ſpace of 24 h. 40'. But for the motion of *Venus*, Monſ. *Caſſini* could perceive the Spots to change their place,

(8) See Philoſ. Tranſ. No. 11, 14.
(9) Coſmotheor. p. 24.

and that the Planet had a Motion, although he could not make out what it was (10).

Thus are the Primary Planets diſcovered to have a *Diurnal Rotation*, or ſomewhat very like it at leaſt, all except *Saturn*, as I ſaid, and *Mercury*, and our own Globe. And as to theſe we have very little, or no reaſon to imagine but that they move as well as the reſt; only we cannot perceive it in *Mercury*, by reaſon of its proximity to the Sun, and that its Elongations are never ſo great, nor ſo long, as to enable us to have any good and ſufficient Views of him with our Teleſcopes.

And as for our own Globe, it is very viſible that either that moves round in 24 hours, or that the Sun

(10) Mr. *Caſſini*'s Obſervations diſperſed in the *Phil. Tranſ.* may be ſeen at one view in Mr. *Lowthorp*'s Abridg. Vol. 1. p. 383, & 425.

and

and all the Heavens move round it in the ſame time. And which of theſe two is the moſt agreeable to the uſual courſe and methods of Nature, which performs all its works in the moſt compendious facile way, let every one judge. And is it not far the moſt compendious, ready and eaſy way that the Terraqueous Globe ſhould wheel about in 24 hours, than that ſo many vaſt Bodies of the Heavens ſhould be turned about it in that time? Is it not as poſſible, yea as probable, that our leſſer *Globe* ſhould be ſo turned about as thoſe more maſſy Globes of the *Sun*, *Saturn*, and *Jupiter* are about their Axes? But I ſhall not enter into a detail of the Arguments for the Earth's Motion, and the Objections made againſt it, becauſe I have done this in the Preface.

Thus having taken a proſpect of the *Diurnal Motions* of the great Globes of the Univerſe, that fall beſt

under the cognizance of our Inſtruments, and found that many, and probably all of them have a Rotation round in a determinate time; if to this we add the *Convenience* and prodigious *Uſe* of this Motion to the ſeveral reſpective Globes, we ſhall find that an infinitely *Wiſe* and *Kind*, as well as *Omnipotent Being* was the *Orderer* thereof. For were thoſe Globes always to ſtand ſtill, eſpecially the Erraticks that owe their Light and Heat to the Sun, in this caſe, one half of them would be dazelled and parched with everlaſting Day, whilſt the other would be involved in everlaſting Night and Darkneſs. And what the conſequences would be, we may beſt judge from what would befall our own Globe, without the kindly Alternations of Day and Night: and that is, that it, at leaſt a great part of it, would ſcarce be habitable, it would neither agree to the

ſtate

ſtate of Man, or any other Animals; nor to that of Vegetables, or indeed any other Creature. For one half of the Globe would be burning up, at leaſt too much drying, and exhauſted with the Beams of the Sun, whilſt the other would be immerged in and deadened with too long Night. And in ſuch a caſe how could the great Works of Nature, ſo ſerviceable to the World, be performed? How, for inſtance, could the Vapours be raiſed to ſupply the Earth with cooling Clouds and fertil Showers? How could the Winds be excited to fan the Atmoſphere with their pleaſant and healthful Gales? How could the Tides be produced, which by their conſtant agitations keep the Waters ſweet and clean, and prevent their poyſoning the World?

And as the Courſe and Functions of Nature would be thus affected, ſo would the State of the Creatures

be no leſs. For how could thoſe of the Vegetable Kingdom be animated and excited by the kindly heat of the Day, and then again tempered and invigorated by the no leſs kindly Dews, and Influences of the Night? How could Men and all other Animals diſpatch their Buſineſs, gather their Food, and perform all the various labours and offices of the day, and then recruit and repoſe themſelves with reſt, ſleep, and due Perſpiration, and whatever elſe may be owing to the ſalutiferous influences of the Night, and abſence of the Sun?

THESE and ten thouſand as great Inconveniences as theſe, would be the certain events of the want of this Diurnal Motion of our Globe. And as the reſt of the Globes have their Shares in the like Motion, ſo we may very reaſonably imagine that it is no leſs uſeful and beneficial to them than

than it is to us, and that the Inconveniences of the want of it would be as great.

CHAP. IV.

Of the Annual or Periodical MOTION *of the Primary Planets.*

BESIDES the Motion treated of in the preceding Chapter, there is another which is as clear a manifeſtation of the great CREATOR as that, namely the *Periodical* or *Annual*, which is viſible in ſome of the great Globes, and probable in many others. Among the Fixt Stars it is highly probable ſomething of this Nature is: as appears from thoſe New Stars which I have before taken notice of, which, as I have ſaid, ſometimes become viſible to us, namely

when they are in that part of their Orbits which are neareſt to our Earth; and then again diſappear, namely when they, in their periodick Motion, are in thoſe parts of their Orbits farther off from the Earth. But theſe Syſtemes being out of the reach of our beſt Glaſſes, I ſhall paſs them by, eſpecially becauſe in our own Solar Syſteme we have abundantly enough to entertain us in this Demonſtration of GOD.

For it is very viſible, without the help of the Teleſcope, that every *Planet* of the *Solar Syſteme* hath this *Periodick Motion* I am ſpeaking of. For it is manifeſt that either the Sun, and the Planets move about the Earth, the one in the ſpace of a year, and the reſt in other times; or that the Earth and the other Planets move about the Sun in ſuch times. But let us (as I have all along done) ſuppoſe the latter, that the Sun is fixt in the Cen-

Center, without any other but its Diurnal rotation in 25 ¼ days: in this caſe, we ſhall have the ſeveral Primary Planets revolving round the Sun in an excellent and due order, by the exacteſt Rules of ſuch a noble Structure, ſuch an admirable Oeconomy, and that is *in Times* (as I ſaid) *in ſquare proportion to the Cubes of their Diſtances.* So that we ſee *Mercury* to perform its Period in near 88 days: *Venus* (the next in order to the Sun) its Period in ſomewhat above 224 days: then the *Earth* with its companion the *Moon* in 365 ¼ days: then *Mars* in about 687 days: next him *Jupiter* in about 4333 days: and laſtly *Saturn* in ſomewhat above 10759 days.

To this ſo ſtrict an order of the *Periods* of thoſe Planets, we may add the conſideration of the different *Paths* of their *Periodical* and *Diurnal motion*: that they lie not in a very different Plane,

Plane, as quite acroſs, or the like; nor exactly in the ſame Plane, but a little croſſing one another; the Diurnal Courſe lying in, or parallel to the Equator; but the other in the broad path of the Zodiack at an inclination of 23½ degrees.

AND a glorious contrivance this is for the good of our Globe, and doubtleſs no leſs for all the reſt that ſympathize in the like motion. For was the Earth's Periodick motion to be always in the ſame Plane with that of the Diurnal, we might indeed be ſometimes nearer to, and ſometimes farther from the Sun; but at the ſame time miſs of thoſe kindly increaſes of Day and Night, together with ſuch uſeful directions of the Sun-beams, which the advances of the Earth to one or other of the Poles cauſe (1): which two things

(1) There are two Cauſes of the great difference between the Winter and Summer, Heat and Cold. One is the ſhorter or longer

are

continuance of the Sun above the Horizon: in Summer long, which increaseth the Heat, as much as it lengthens the Day: in Winter short, which diminishes the Heat as it shortens the Day; and augments the Cold, as it lengthens the Night. The other cause is the Oblique or Perpendicular direction of the Sun's rays, the Oblique being weaker than the Perpendicular; as is evident from *Galileo*'s experiment, in his *Systema Mundi*. Dial. 1. by holding a Paper turned up at right angles, or a Book half open; over against an illuminated white Wall; where it may be observed that the side opposite to the Wall, which the Rays strike perpendicularly, is far more light and white than the other side, on which the Rays fall obliquely. The same it is in the Incidence of the Sun's Rays on any Plane, namely the Rays are so much stronger, and the Plane the more warmed and enlightened, as the Rays are more or less perpendicular; and that on two accounts. 1. Because the Perpendicular Rays strike with greater force than the Oblique: As in Fig. 4. the Rays *R R* strike the Plane *A P* more forceably than the Plane *O B*. The Action or Force of which Percussion is (like that of all other Impulses) as the Sine of the Angle of Incidence. So the Force of the Rays *R R* upon the Oblique Plane *O B*, is as the Sine only of *R O B*, whereas their Force upon *A P* is as the whole Sine of 90 degrees, or Angle *R O P*. 2. Another Reason is, That a greater number or quantity of Rays fall within the compass or Area of any Plane in

are the real cauſes of our Seaſons of Summer and Winter, Spring and Au-

a Perpendicular than Oblique direction. This will be manifeſt from the bare inſpection of Fig. 4. Where it may be obſerved that all the Rays between *R R* and *O p* fall on the Plane *A P*; but only about one half of them would fall upon an Oblique Plane of the ſame length, if it was *O b*: or (which is the ſame thing) near as many Rays would fall off *O b*, turned up to *O b*, as fall upon it. Alſo it may be obſerved farther, that as the Line *O B* is longer than *O p* ſo are the Spaces between the Rays larger in *O B* than *O p*; and conſequently fewer Rays fall on *O B* for its length, than on *O p* for its length, or the Rays are denſer, or more compact in *O p* than *O B*. And when they are ſo, they are ſo much the ſtronger, as is evident from the collecting and condenſing the Sun's rays by a Burning-glaſs.

What the particular Power of the Sun's rays is in all Directions, Quantities, and Impulſes, falls under Mathematical calculation; but I need not trouble the Reader with it, but ſhall refer to the ingenious Dr. *Wolfius*, Mathematical Profeſſor of *Hall's*, *Elementa Aerometriæ*. And as for the proportional degree of the Sun's heat in all Latitudes, and all its Altitudes, our moſt acute *Savilian* Profeſſor, Dr. *Halley*, hath given us a neat and clear method for computing it in *Philoſ. Tranſact.* No. 203.

tumn,

tumn, and not our being nearer unto, or farther from the Sun. For thoſe benefits (we at leaſt that inhabit towards the Northern Pole) have at the contrary Seaſon, when we have moſt need of them, *viz.* the Sun's proximity, in Winter; its greater diſtance from us in Summer; as is manifeſt from the increment of its apparent Diameter in Winter to 32'. 47", and the decrement thereof in Summer to 31'. 40". (2).

(2) Monſieur *de la Hire* in his *Tabul. Aſtron.* makes the Sun's Semidiameters to be *Dec.* 30. 16' 22" and *Jun.* 30. 15' 49". But Mr. *Flamſteed* in his *Lunar Tables* added to Mr. *Horrox's Poſthumus Works* makes the greateſt to be 16'. 23" the leaſt 15'. 50". and the *French Academiſts* 16'. 23". and 15'. 50". V. *Recueil d' Obſerv. Les Elemens d' Aſtron.* p. 22.

Beſides the alteration of the Sun's apparent Diameter, its ſwifter motion in Winter about the Solſtice by about a 15th part, is an argument of its being then nearer the Earth. From whence it comes to paſs that from the Vernal to the Autumnal Æquinox, there are

AND now for a Concluſion of this chapter concerning the Periodick Motions of the Primary Planets, we may take up the Argument of *Hugo de S. Victore* (3), *Who commandeth the Sun to deſcend through the Winter Signs? And who again cauſeth him to aſcend through the Summer Signs? Who leads him from Eaſt to Weſt? And who again brings him back from the Weſt to Eaſt? All theſe things are very wonderful, but to God alone poſſible.*

about 8 days more than from the Autumnal to the Vernal.

(3) *Quis ſolem per hyberna deſcendere ſigna præcipit? Quis rurſum per æſtiva ſigna aſcendere facit? Quis eum ab Oriente in Occidentem ducit? Quis iterum ab Occidente in Orientem revehit? Hæc cuncta ſunt mirabilia, ſed ſoli Deo poſſibilia.* Didaſcal. L. 7. c. 8.

CHAP.

CHAP. V.

Of the Periodical Motion of the Secondary Planets.

HAVING conſidered the Periods of the *Primary Planets*; let us next caſt our eye upon thoſe of their *Secondaries*. And among theſe we ſhall find the ſame compleat order and harmony as among the laſt. Thus *Saturn*'s five Moons, and *Jupiter*'s four, and our own about the *Earth*, have each of them their determinate times, ſome longer, ſome ſhorter intervals of time, in the ſame due proportion, as I ſpake of among the Primaries.

BESIDES which, there is another thing very conſiderable in this Periodical Motion of thoſe Secondary

Planets, and that is, that it is mixt with a kind of *cochleous* Direction towards one or other Pole of the Primary Planet; by which means every *Satellite* by gentle degrees changeth its Latitude, and makes its visits towards each Pole of its *Primary*. This is well known among the *Circumjovials* for instance, that they all have a slow and gradual progress, first towards one, then back again towards the other Pole of *Jupiter*: and that each Satellite hath its Latitude greater and greater according as it is farther or farther from *Jupiter*'s Body. Accordingly the Latitude of each *Circumjovial*, assigned by the diligent and sagacious *Cassini* (4), after 12 years observations, are these. The greatest Latitude of the *First*,

(4) *Les Hypoth. & les Tables des Satel. de Jupiter*, § 4. in the *French* Academist's large Collection.

or *Neareſt*, exceeds not a third part of *Jupiter*'s Semidiameter: that of the *Second*, ſurpaſſeth but a little of a quarter of its Diameter: that of the *Third* a little exceeds three quarters of the Diameter: and that of the *Fourth*, or *Outermoſt* goes beyond *Jupiter*'s Poles by a third part of the Semidiameter. All which mutations, he ſaith, are performed in the ſpace of 12 years. Thus the famous *Caſſini*. But I have my ſelf obſerved a greater vagation in the *Third Satellite*, that it advanced near to, if not even with the very Limb, or Pole of *Jupiter*, and that its Stay in *Jupiter*'s Shadow, or the Duration of its Eclipſe at that time, was leſs than is commonly aſſigned unto it, as it is reaſonable to imagine it ſhould be, becauſe the Satellite had only the outſide of the Cone of *Jupiter*'s Shadow, and conſequently a leſſer part thereof to paſs thorough at that time.

all at first put into Motion by one and the same unerring Hand, *even the infinite* Power *and* Wisdom *of* God, *who hath fixed this Order among them all, and hath established a Law which they cannot transgress. Chance or dull Matter could never produce such an Harmonious Regularity in the Motion of Bodies so vastly distant: this plainly shews a Design and Intention in the First Mover. And with submission to the Reverend and Learned Divines, I am apt to think, that one Argument drawn from the Order, Beauty and Design of things is more forcible against Atheism, than multitudes of Notional Proofs*, &c. Thus Mr. *Molyneaux*. But we shall find farther Evidences of this *Supreme Management* in these matters from what follows in the next Chapter.

CHAP.

CHAP. VI.

The Conſtancy and Regularity of all the Motions of the Earth and Heavens.

THAT the Earth and Heavens move at all, but eſpecially that they have ſuch particular and beneficial Motions, appears, from the preceding Chapters, to be the work of God. And the concurrence of the ſame infinite Hand is as manifeſt in the Perpetuity, Conſtancy, and Regularity of thoſe Motions. For without this *Almighty Guide* and *Manager*, how is it poſſible that all thoſe vaſt and unweildy Maſſes ſhould continue their beneficial Motions throughout all ages? ſhould perform their uſeful Stages without any the leaſt intermiſſion, interruption or diſorder that we know of? What

Motion, what Contrivance, what piece of Clockwork was there ever under the whole Heavens, that ever came up to ſuch a perfection, and that had not ſome ſtops, or ſome deviations, and many imperfections? But yet none was ever ſo ſtupid as to conclude ſuch a Machine (though never ſo imperfect) was made by any other than ſome Rational Being, ſome Artiſt that had skill enough for ſuch a Work. As he in *Cicero* (1) argues from his friend *Poſidonius*'s piece of Watch-work, that ſhewed the motions of the Sun, Moon and five Erraticks; that if it had been carried among the *Scythians* or *Britains*, *Quis in illâ barbarie dubitet, quin ea Sphæra ſit perfecta Ratione?* with more to the ſame purpoſe: no man even in that ſtate of Barbarity would make any doubt whether it was the

(1) De Nat. Deor. L. 2. c. 34.

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workmanſhip of Reaſon or no (2). And is there leſs Reaſon to imagine thoſe Motions I have been treating of to be other than the work of God, which are infinitely more conſtant and regular than thoſe of Man! Or to uſe the laſt mentioned *Stoick*'s argument, can it be thought that *Archimedes* was able to do more in imitating the Motions of the Heavens (in his Sphere) than Nature in effecting them?

And now to reflect upon the whole, and ſo conclude what hath been ſaid concerning theſe ſeveral Motions: We may all along perceive in them ſuch manifeſt ſignals of a divine hand, that they all ſeem, as 'twere, to conſpire in the demonſtration of their infinite CREATOR and ORDERER. For beſides what in all probability is in other parts of

(2) See the place cited at large in my *Phyſico-Theology*, p. 2.

the Univerſe, we have a whole *Syſteme* of our own manifeſtly proclaiming the Workmanſhip of its *Maker*. For we have not thoſe vaſt and unweildy Maſſes of the Sun, and its Planets, dropt here and there at random, and moving about the great *Expanſum*, in uncertain Paths, and at fortuitous Rates and Meaſures, but in the compleateſt manner, and according to the ſtricteſt rules of Order and Harmony; ſo as to anſwer the great ends of their Creation, and the divine Providence, to diſpatch the noble Offices of the ſeveral Globes; to perform the great Works of Nature in them; to comfort and cheriſh every thing reſiding on them, by thoſe uſeful changes of Day and Night, and the ſeveral Seaſons of the Year.

THESE things are ſo evident to the Reaſon of all men, that *Tully* might well make his *Stoick* to alledge this

this as one of his principal arguments for the proof of a Deity (3); *The fourth cause*, saith he, *and that even the chief, is the Equality of the Motion, and the Revolution of the Heavens; the distinction, utility, beauty and order of the Sun, Moon, and all the Stars: the bare view alone of which things is sufficient to demonstrate them to be* no works of Chance. *As if any one should come into an house, the Gymnasium, or Forum; when he should see the order, manner and management of every thing, he could never judge these things to be done without an Efficient, but must imagine there was some* Being *presiding over them, and whose orders they obeyed. So much more in so great Motions, such Vicissitudes, and the Orders of so many, and great things; ——a man cannot but conclude, that such great acts of Nature are gover-*

(3) De Nat. Deor. L. 2. c. 5.

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ned by ſome Mind, ſome Intelligent Being.

And ſo again afterwards (Chap. 21.) when, among other things, he had been ſpeaking of the motions of the Planets, he thus argues, *I cannot poſſibly underſtand,* ſaith he, *how all this conſtancy can be among the Stars; this ſo great agreement of times through all eternity, among ſuch various courſes* (how this can be) *without ſome Mind, Reaſon and Counſel.* And a little after this, ſpeaking of the Fixt Stars, he ſaith, *But the perennial, and perpetual Courſes of thoſe Stars, together with their admirable, and incredible conſtancy declare a Divine Power and Mind to be in them.* And this he takes to be ſo plain a caſe, that he that could not diſcern it, he thinks, could diſcern nothing. And then he thus concludes, *In the Heavens then, there is neither any Chance, nor any temerity, nor errour, or vanity: but on the contrary, there*

there is all order, truth or exactneſs, reaſon, and conſtancy. And ſuch things as are void of theſe are counterfeit, falſe, and full of error. — — — He therefore that thinks the admirable celeſtial order, and incredible conſtancy, on which the conſervation and good of all things depends, to be void of a Mind, he himſelf deſerves to be accounted devoid of a Mind. Thus with great Force and reaſon *Tully*'s *Stoick* rightly infers the preſence and concurrence of a *Divine Being and Power* from the Motions of the Heavens: only not being aware who that Being was, he erroneouſly imagines the Heavenly Bodies themſelves to have Divinity, and puts them therefore into the number of the Gods.

BOOK V.

OF THE *FIGURE* Of the ſeveral GLOBES of the Univerſe.

CHAP. I.

The conſonancy of all the GLOBES in their Spherical Figure.

HAVING in the preceding Book manifeſted the *Motions* of the Earth and Heavens to be the Contrivance and Work of GOD, I ſhall en-

enquire in this, whether their *Figure* be of the ſame kind, ſuited to the Motions, and in a word, to the whole ſtate and convenience of the ſeveral Globes.

Now as to the *Figure*; it is obſerveable in the firſt place, that there is a great Conſent therein among all the Globes that fall under our view, and that is that they are all Spherical, or nearly ſo, namely Spheroidal (1). Thus all the Fixt Stars, ſo far as we are able to behold them either with our naked eye, or our Glaſſes. Thus the Sun, and thus all its Planets, and thus the Secondaries, or Moons accompanying *Saturn*, *Jupiter*, and our *Earth*. And although *Venus*, *Mercury*, and our *Moon* have *Phaſes*, and appear ſometimes Falcated, ſometimes Gibbous, and ſometimes more or leſs round;

(1) See *Phyſico-Theol.* B. 2. ch. 1. Note 1.

and

and even *Mars* too, in its Quadratures, becomes Gibboſe; yet at ſuch times as theſe Planets ſhew their full Phaſes, they are found to be ſphærical, and only loſe this figure by vertue of their poſition to the Sun, to whom they owe their Light. And this ſphæricity, or rotundity is manifeſt in our *Moon*, yea and in *Venus* too; in whoſe greateſt Falcations the dark part of their Globes may be perceived, exhibiting themſelves under the appearance of a dull, and ruſty colour.

And as this Sphærical Figure holds in every of the Globes at a diſtance from us, ſo we may reaſonably imagine our own Globe to be conſonant to the reſt. But indeed we have great reaſon to conclude it to be ſo from the Curvity of its Shadow in its Eclipſes of the Moon; from the diſcovery of New Conſtellations in the Heavens, as we change our

our Hemiſphere, and make approaches towards either Pole: from the Surface of the Sea, which appears to be of this figure, by our gradually diſcerning far diſtant Objects, Mountains, Towers, Sails of Ships, &c. the parts of which are more and more ſeen, as we approach nearer and nearer to them: with other arguments to the ſame purpoſe, which I need not enumerate in a caſe now generally owned to be true.

CHAP. II.

Of the Inequalities, or Hills and Vales obſervable in the Earth and Moon.

HAVING in the preceding chapter demonſtrated the ſeveral Globes of the Univerſe to be Sphærical, it is not to be underſtood that

that theſe Globes are ſtrictly ſo; but an allowance is perhaps to be made for the difference between their Æquatorial and Polar Diameters, before ſpoken of: but eſpecially for thoſe little and inconſiderable excreſcences of the Hills, very manifeſtly diſcernable in the Moon (1), as well

(1) Every one that hath viewed the *Moon* with but an ordinary Glaſs, eſpecially when ſhe is not round, may eaſily perceive conſiderable Unevenneſſes; that ſome parts are manifeſtly higher, and others lower. About the Quarters, divers bright golden Spots may be ſeen in the ſhaded part, at ſome diſtance from the enlightned part; and theſe may be perceived to grow larger and brighter, as the Shady part turns more and more towards the Sun; till at laſt you may ſee all the intermediate Vallies between thoſe Spots, and the other enlightened parts. Alſo in divers parts of the Moon, eſpecially ſuch as border on the ſhaded part, there may be obſerved to be certain Holes or Pits, black, dark, or ſhady, when the parts encompaſſing them are luminous and bright. And this darkneſs, as if under ſome Mountain, lies always on the ſide next the Sun, and gradually goes off, as the

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as in our own Globe; which I call little and inconſiderable, eſpecially thoſe in the Earth, becauſe they are ſo in proportion to the Earth's Diameter; as will appear by coming to particulars. The Diameter of the Terraqueous Globe I have ſhewn in

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Hole, Pit, or Valley turns more and more towards the Sun, till at laſt the whole Valley is enlightened, and looks like a depreſſed ground in the body of the Moon. All which things are manifeſt ſignals that the Moon's ſurface is not even and ſmooth, but like that of the Earth, full of Hills and Valleys.

Which opinion, although now well grounded, on ocular demonſtration, was as old or older than *Plutarch*'s days, who in his Book *de Facie in orbe Lunæ*, at the beginning, cites it as *Clearchus*'s opinion Εἰκόνας ἐπιφανείας ἀναγ ειδώλα τῆς μεγάλης θαλάσσης——i. e. *That what is called the Face of the Moon are the Images and Appearances of a great Sea in the Moon.* And about the middle of that Tract, Τὸ δὲ φαινόμενον τῆς σελήνης——i. e. *As to that Face which appears in the Moon; as our Earth hath certain large Bays; ſo we conceive the Moon is overſpread with large hollows and ruptures, containing Water, or a thick dark Air, into*

my *Physico-Theology* (2) to be about 7935 English miles; but that of the Hills is no more than a few miles. *Snowdon* in *Caernarvonshire* (the highest Mountain in all our Island) is but 1247 yards (3); the *Alps* themselves

which the Sun beams are not able to enter, and so no Reflection is made by them.

As to other matters in which the Earth and Moon seem to agree, as in Seas, and great collections of Waters, an Atmosphere, &c. I shall pass them by here as improper for this place.

(2) Book 2. Ch. 2. Note

(3) In the Journal of the late ingenious *Richard Towneley*, Esq; of *Towneley* in *Lancashire*, I find this Note upon *Sept.* 6. 1682. *This day Mr.* Adams *called here who is taking a Survey, &c. He told us that with repeated trials he had found* Snowdon-hill 1320 *yards higher than the High-water mark, and that the Quicksilver stood at the bottom at* 29 *Inches; at the top at* 25,96: *So that* 1320 *gave* 3,04. Then follows this Note, *viz. Mr.* Adams *coming since tells me, that the Height of* Snowdon *was but* 1247 *yards; which gave* 3,04.

The reason of this difference of 73 yards, in the height of *Snowdon* I take to be, that the first measure was made by Mr. *Adams* himself,

but

but about two Engliſh Miles (4): nay the very *Pike of Tenariffe*, one of the higheſt Ridges throughout the Globe (unleſs we except the high Mountains of *Peru* called by *Joſ. Acoſta* (5) *Periacaca*; or that near St. *Martha* (6); or thoſe called the *Andes* (7); this Ridge (I ſay) is compu-

the latter by Mr. *Caſwell* with Mr. *Adams*'s Inſtruments; and probably the former is the Height above the Sea: the latter only above ſome plane.

(4) Mr. *Nich. Fatio* told me that he had meaſured the Height of the *Montagne Mauditi*, which is one of the higheſt Ridges of the *Alps*, and that he found it to be 2000 French Toiſes above the *Lake of Geneva*, which is equal to 12816 Engliſh Feet, or 2,42 miles.

(5) *Acoſta* ſaith the *Alps* ſeemed to theſe Mountains he travelled over, but as ordinary Houſes to lofty Towers. See my *Phyſ. Theol.* B. 1. ch. 1. Note 2.

(6) Capt. *Dampier* ſaith that he is of opinion that the Hill near St. *Martha* is higher than the *Pike of Tenariffe*. Voyage round the World, p. 24.

(7) Of the *Andes* of *Chili* and *Peru*, Capt. *Dampier* ſaith, *Theſe are the higheſt Mountains I*

ted to be but between 3 and 4 miles perpendicularly above the Sea (8). All which Eminences compared with the Diameter or Semidiameter of the Earth is no more than as a particle of Duſt is to a large Globe, on which it reſteth.

AND ſo likewiſe for the Mountains viſible in the Moon, although ſome of them are of that height (9), as to

ever ſaw, far ſurpaſſing the Pike of Tenariffe, *or* Santa Martha, *and I believe any Mountains in the world.* Ibid. p. 95.

(8) See Dr. *Hooke's* account of the *Pike of Tenariffe* from his Friend Mr. G. T. who went to the top of it; at the end of his *Lectures concerning Springs* p. 42.

(9) By *Riccioli's* Meaſures the Height of what he calls *Mount Sinai*, or St. *Katharine's Hill*, is 9 *Bononian* miles, and that of *Taurus* 12, but according to his corrections, the former is but 8 $\frac{4}{21}$ miles, the latter 11$\frac{1}{3}$. Which at the rate of 6020 *Engliſh feet* in a *Bononian mile*, is about 13 and 9 *Engliſh* miles; an height ſo great, conſidering how much the Moon is leſs than the Earth, that I cannot but think that diligent perſon was miſtaken in his meaſures, and that the compara-

reflect

tions of *Hevelius* are much the beſt: who as he was as able as any man, and made more accurate and diligent obſervations of the Moon's Face than moſt men ever did, ſo was more likely to come neareſt the truth. And by his reckoning, the higheſt Hills in the Moon are but about $\frac{1}{4}$ of a *German* mile, and ſome of them but $\frac{1}{5}$ths, and ſome not above an *Italian* mile. And conſidering the Bulk of the Moon to that of the Earth, theſe are great Eminences for the Moon.

And as the *Lunar Mountains* are of prodigious Heights, ſo many of them are of great Extent. *Hevelius* reckons the *Lunar Taurus* to reach to 170 *German* miles; *Mount Sepher* 150; and the *Lunar Apennine* above 100 *German* miles.

The Way how to meaſure the Height of the Mountains of the Moon is not difficult, nor uncertain: which is, by obſerving the diſtance between the diſtant golden Spots, at their firſt appearance (which are the tops of Hills) and the enlightened part of the Moon. Which Diſtance may be computed by miles, or any other equal parts, into which we can imagine the Moon's Diameter divided. Thus in Fig. 5. *A R B* is a part of the Moon's Circumference, one part of which *AR* is enlightened, the other part *R B* is in darkneſs. *Hi* is a Mountain, whoſe top *H* is touched by the Sun-beams, ſhining from *S* the Sun to *R*, and reaching to *H*. Now ſuppoſing the Semidiameter of the Moon, *RC*, to be 274 *German* miles, according to *Hevelius*, the length of the ſide *RH* (or Diſtance

reflect the Light of the Sun from their lofty Tops ſome days before ever it reacheth the Vallies beneath them; yet on the Moon's Limb we can diſcern nothing of them: but ſo far from that, that, on the contrary, the Edge through our beſt Glaſſes, looks like an even, ſmooth, and uninterrupted Circle (10)

ſtance between the Top of the Hill, and the edge of the enlightened part) will be found alſo to be a 10th, 20th or other part of that Semidiameter or Diameter; or ſome certain number of miles. And then we have the two ſides *R C*, 274 miles, and *R H*, and the right Angle included between them; by which, both the other Angles, and the Side *C H*, may be found by a common Caſe of Right angled Triangles. Out of which ſide *C H*, deducting the Moon's Semidiameter 274, there remaineth the Height of the Mountain *H i*. Conſult here *Hevel. Selenogr.* ch. 8. *Galilæus Nunc. Sider.* p. 14. *Riccioli Almageſt.* L. 4. c. 8. Schol.

(10) The Edge of the Moon which I here mean is that next the Sun; on which I could never perceive with my beſt Glaſſes any, the leaſt ſign of a Mountain, but all to be exactly level and ſmooth. Only indeed there are ſome certain tranſient roughneſſes and uneven-

A L-

ALTHOUGH then vaſt Mountains, when ſeen near at hand, ſeem to be very conſiderable excreſcences of our Globe, yet ſince they are little, when compared to the Globe it ſelf, we

neſſes on the Limb cauſed by Vapours eſpecially when the Moon is near the Horizon, and in windy, and ſome other weather. At which times the motion of the Air and Vapours makes a pretty Criſpation and Rouling like Waves on the Moon's Limb, which have the appearance of moving Mountains and Valleys. But on the oppoſite ſide, if the leaſt portion of the Darkened part of the Moon, extends beyond the Enlightened part, Mountains may very manifeſtly be diſcerned, exactly reſembling ours on the Earth. A few hours before and after the Full, I have with pleaſure ſeen the appearance of conſiderable Mountains and Bays. One of which Views, I have given in Fig. 6. which is the Moon's appearance, ſoon after the Full, on *Sep.* 12. 1714.

Theſe alone I conceive are the Mountains which the excellent *Hevelius* ſpeaks of in ſeveral places of his *Selenography*, particularly in his Anſwer to *Bettinus*, and other *Peripateticks*, in Ch. 6. p. 143. who denied that Mountains could be in the Moon, as well as many other things diſcovered now by the Teleſcope.

may look upon our own, and all the reſt of the Globes as if they were perfect Sphæres, or at leaſt Sphæroids. And finding them to be ſuch, let us next enquire what reaſon there is to imagine this their Form to have been the *great* CREATOR's *Work.*

CHAP. III.

The Univerſality and Uniformity of the Figure of the ſeveral Globes of the Univerſe is a ſign of their being the Work of GOD, *not of Chance or Neceſſity.*

WHEN we ſee divers Pieces of curious Device and Work-manſhip to bear the ſame marks of Art, to have the ſame maſterly ſtrokes of Painting, Clock-work, Architecture, &c. we conclude with great

great reaſon ſuch Pieces were made by the ſame skilful Hand. So when we ſee the ſame commodious Sphærical Figure to be imparted to the Earth, and all the Heavenly Bodies, we have as good reaſon to conclude them to be Pieces of the ſame Hand, Contrivances and Works of the ſame skilful Architect. For if the Univerſe had been a work of *Chance*, all the ſeveral Globes would have been of ſeveral Forms, one of this, another of a quite different Figure: one ſquare, another multangular, another long, and another of another ſhape. Or if all the ſeveral Globes had been a work of *Neceſſity*, and their Figure had been owing to the natural tendency, or Gravity of Matter, *viz.* that the Self Attracting power of Matter did make all the Solids and Fluids of all the ſeveral Globes, as naturally run into a globoſe form, as a drop of Quickſilver doth: yet ſtill

we

we may demand, How came Matter by this ſo commodious a Power? What made it affect ſo proper a Form but the infinite CREATOR's *Fiat*?

But not to conteſt that Point, but granting *Gravity* to be congenial and coeval with *Matter*, without enquiring how it came by that power; and allowing that every Globe of the Univerſe had its Form from the *Self-attracting* power of its Matter, yet ſtill we have undeniable marks of *Final Cauſes*, of wiſe *Order*, and an over-ruling *Power* in the caſe. For let us imagin our Terraqueous Globe in its Chaotick ſtate; all its Matter, every particle of it divided, and floating about, and ready by its ſelf-attraction to run together into its natural form, that of a Globe. In this hurly burly, this jumble of unguided Nature made by Attraction only, a confuſed globoſe Maſs can be

be supposed to be formed; but without any order, without that convenient lodgment of its parts, as the necessities of an habitable World require. But instead of any such signs of disorder, or of Nature's acting with an unguided Power, we have the clean contrary; all the Signals of a wise Contrivance, and excellent Art; as will appear in the following Chapter.

CHAP. IV.

The Terraqueous and other Globes appear to be the work of GOD from the wise disposition of their parts.

AS the Earth, and all the other Globes would have been of various Forms, if they had been made by *Chance*: or would have been

been confuſed Maſſes, if made by *Neceſſity*, according to the laſt chapter: ſo in this I ſhall ſhew them to be the Work of a *Wiſe* and a *kind Agent*, from the commodious ſtructure and diſpoſition of their parts, ſo far as we have any knowledge of them. Thus the *Moon* hath great appearances of being no leſs commodiouſly than the Earth divided into Hills and Valleys (as I have ſet forth in the 2d Chapter;) into Dry-lands, and great Collections of Waters (1),

(1) That there are Seas, or great Collections of Waters in the Moon is highly probable from the *Moon's Spots*, which plainly ſeem to be Water on theſe two accounts, 1. Becauſe thoſe Spots appear to be in ſtrait and level long Planes, when viewed about the Moon's Quarters, or at ſuch times as one half of them are enlightened, the other half in darkneſs. In this caſe, when we do not look directly upon thoſe Planes or ſee them wholly enlightened, but view them in a manner ſideways, their Surfaces look as the Sea doth when we view it from the Shore, *viz.* a large level

and

Plane: only we may now and then diſcern a bright ſhining part ſtanding a little out of the large Levels, which are, no doubt, certain Rocks or Iſlands in the midſt of thoſe Seas. 2. The Darkneſs of thoſe Spots more than other parts of the Moon is an argument they are Water, or ſome ſuch like Fluid, which imbibes the Sun's Rays more than harder Bodies, and doth not therefore ſo vigorouſly reflect them as they do. Accordingly about the Moon's Quarters, when thoſe Spots, as I ſaid, have the appearance of long Planes, we may obſerve their edge to be a kind of hazy border, which grows darker and darker, as the Rays are more and more abſorbed.

But indeed hard Bodies, if they have ſmooth ſurfaces, although they reflect ſtrongly to one place, yet in other places they are leſs viſible. Thus a Looking-glaſs, a Diamond, *&c.* reflect vigorouſly the Sun's rays towards one part, ſo as to dazle the eyes; but in other parts they appear of a dark, blackiſh hue. Which by the bye, is the reaſon why Jewellers grind their Diamonds with many ſides and angles, that their luſtre may appear many ways. So Silver (as *Galilæo* obſerves, Dial. 1.) when boiled only in *Argol* and *Sal* appears as white as Snow; but wherever it is burniſhed, it becomes obſcure. And ſo he tells us rightly enough the *Moon* would become inviſible to us, if its ſurface was not rough, but ſleek and ſmooth. See alſo *Hevelii Selenogr.* ch. 6. p. 151.

(2) That

and to be encompaſſed with an Atmoſphere as we are (2). So *Jupiter* although at ſo great a diſtance from us, hath manifeſtly, we ſee, his lighter and darker parts; his *Belts* and Spots darker than the reſt of his Diſk. Theſe Mr. *Caſſini* (who longer viewed this Planet than any body elſe) takes to be Canals containing ſome fluid matter, or Water, that more weakly reflects the Sun's rays than the other parts of the Planet do, and that they have ſome reſemblance with what happens here upon Earth. (3) *For if*, ſaith he, *one from on high in the Heavens ſhould ſee the Earth in ſome particular ſituations, the Sea which encompaſſeth the Earth would appear very*

(2) That there is an *Atmoſphere* about the *Moon*, ſee Book 7. ch. 3. Note 1.

(3) *Nouvelles Decouvertes de Jupiter, par M. Caſſini* in the *Memoires de Mathem. & de Phyſique* for *January*, 1692.

like

like the great Southern Belt that encompaſſeth the whole globe of Jupiter; *the Mediterranean Sea would make an appearance not unlike thoſe Belts which are interrupted or broken, which we ſee in this Planet: the other Seas would make thoſe great black Spots which never alter at all: the Continents and Iſles would ſeem like thoſe bright Spots that are alſo permanent: the Snows would make thoſe glittering Sparkles* [Brilliants] *that from time to time diſappear: the Flux and Reflux of the Ocean, and thoſe great Inundations that happen ſometimes here, would occaſion other Spots to appear and diſappear: the Moon would reſemble one of* Jupiter's *Satellites: in fine, the Clouds of our Atmoſphere would reſemble thoſe broken interrupted Belts, and thoſe tranſitory Spots, which often change their ſize and figure, and have motions of different velocities.*

THUS that ingenious and curious Obſerver. According to whoſe not

improbable opinion, this Planet *Jupiter* hath all its parts orderly placed, as it is here upon earth.

And ſo for the reſt of the Planets, whoſe Faces exhibit different appearances of brighter and darker parts, as *Mars* and *Venus* particularly do (4); it is highly probable that theſe may be ſuch a diſtribution, ſuch an allotment of Parts, as thoſe in *Jupiter*, and which are more plainly viſible in our own Globe.

Which brings me to ſpeak particularly of our own Globe, of which we have a nearer View, and can plainly ſee the footſteps of Divine Providence in the wiſe and orderly diſpoſition of all its parts; which are ſo diſtributed, ſo placed, as may beſt miniſter to the ſeveral uſes and conveniences of an habitable World.

(4) See Book 4. chap. 3.

Thus for inſtance, the two grand parts, the Solids, and the Fluids of the Terraqueous Globe, inſtead of being jumbled into one Maſs, are admirably parted, and as nicely laid in proper places. The *Earth* depoſited in uſeful *Strata*; ſome for the ſervice of the Vegetable kingdom; ſome for the generation and nouriſhment of Minerals and Metals; ſome for that of Stones and Foſſils; and ſome for the ſweetening and conveyance of the Waters. And here it is remarkable, and an argument of a wiſe deſign and appointment, That all thoſe ſeveral *Strata* or Beds are lodged at proper and convenient depths and diſtances from the Surface; that for Vegetables, the uppermoſt, for every man to cultivate; and this divided into various Soils and Moulds for all the varieties of Trees and Plants; thoſe *Strata* that contain the Minerals, Metals, and Foſſiles, at

ſuch depths, as to be out of the way, when they may encumber or hurt us, but may be come at by us, when we have occaſion for them: and as for thoſe *Strata* that convey the Sweet waters (5) it is very remarkable, that they are ſo univerſal, in all, or moſt parts of the World; that they conſiſt of ſuch proper pervious matter; that they remain ſo diſtinct from, and unmixed with the other *Strata*, and that they lie at ſuch due depths, as either to break out in Fountains, or to be dug into, for Wells. But I ſhall not enlarge on theſe matters, having ſpoken of them elſewhere.

And as this ſo commodious a diſtribution of the *Earth*, ſo that of the *Waters* is a manifeſt demonſtration of the concern of a *wiſe Agent*, although we ſhould aſcribe all that is

(5) See *Phyſico-Theol.* Book 3. ch. 2.

poſſible

poſſible to the neceſſities of Nature in the formation of the World. For the Waters, if we obſerve them well, are accurately diſperſed, and lodged about the world for the proper offices thereof; in Seas, in Lakes, in Rivers, in Fountains, to ſatisfie the Thirſt of Animals, to afford them ſome part of their Food, and to miniſter abundant ſupplies of Vapours for the Clouds, the Rains, and Winds: which Supplies muſt either have failed, or have been too abundant, or have been attended with ſome or other great inconvenience, without ſuch a commodious intermixture of the Land and Waters.

THIS Συναγωγὴ, this orderly *gathering together* of the Waters, is implied in *Moſes*'s relation of this branch of the Creation, *Gen.* 1. 9. *And God ſaid, Let the Waters under the heaven be gathered together unto one place.* Where the word מקוה denotes

a regular and orderly *gathering of the Waters*, as if their Allotment had been made, their Receptacles had been marked out by a Rule, or a Plumb-line, by the CREATOR's *Fiat*.

THUS it is demonſtratively plain, that the Earth and Waters were laid by a wiſe Hand; and therefore whatever concern *Nature* might have in giving a Sphærical Figure to our Globe, yet was the CREATOR the principal *Agent*, the grand *Manager* of the matter.

CHAP

CHAP. V.

The Convenience and Neceſſity of a Spherical Figure to the Good of the Globes is an argument they were the work of GOD.

BESIDES the orderly and commodious placing the Parts of the ſeveral Globes ſpoken of in the laſt Chapter, there are ſtill other reaſons to aſcribe the Sphericity of our own and the other Globes to a *wiſe Agent*. For beſides that this Figure is the moſt agreeable to a World, as being the moſt capacious; and the moſt agreeable to a Maſs in motion; as being at a due diſtance from the center of Motion and Gravity: ſo without this figure there could have been no ſuch comfortable, and agreeable alternations of Day and

Night, of Heat and Cold, as now there are, but ſome parts muſt have been for too long a time skreened from the kindly approaches of the Sun and Moon, and conſequently have lain under too long and uncomfortable a Darkneſs, and been chilled with miſerable Cold. And as to our own Globe, the Winds could not have given thoſe kindly and ſalutiferous agitations to the air as they do, but they muſt have been too much retarded, if not wholly ſtop'd by the exorbitant angles, and jettings out of other figures. And laſtly, the Waters which I ſhewed to be well intermixed with Dry-Land, would have had intolerable Confluences; one part too much, another none at all, no Vapours, no Fountains, no Rivers: ſo that inſtead of an habitable, well ſtocked world, far the greateſt part would have been either a Deſart, or an unneceſſary Confluence of Water.

Thus

THUS having made it evident, that particularly our own Globe received its Figure by the direction of the infinitely wiſe *Architect* of all things: we have reaſon, had we none beſides, to conclude the ſame of all the reſt of the Globes of the Univerſe, inaſmuch as they agree with ours in other things as well as in their Figure, ſo far as we have any knowledge of Them, and their State. Thus the Planets of the Solar Syſteme have their Light from the Sun as well as we; they turn round on their own Axes, and revolve round the Sun, and conſequently have their Days and Nights, their Summers and Winters as well as we; they have their Hills and Valleys as I ſaid, their Land and Waters, by all the Signs that may be, as well as we; and therefore agreeing with our Globe in ſo many of thoſe very things wherein their Figure is concerned, had we none of thoſe Reaſons I

have already mentioned, there would however be great reaſon to preſume the ſame thing of them as of our Earth, *viz.* That they received their Figure from the ſame wiſe CREATOR, and that (were we near enough to behold them) they have as manifeſt Signals of it as we.

BOOK

BOOK VI.

OF THE *Attraction* or *Gravity* OF THE Terraqueous, and the other Globes.

CHAP. I.

The Uſefulneſs of Attraction *in the production and preſervation of the Figure of the Earth, and the Deſcent of Heavy Bodies.*

HAVING in the two laſt Books treated of the Motions and Figure of the Globes, I ſhall in this conſider their *Gravity* or *Attraction*, which

which according to the modern Philoſophy (which hath great reaſon and probability on its ſide) hath a great agency in both theſe matters, both in effecting and preſerving the Figure of the Globes, and goyerning their Motion.

As to the agency of the natural Attraction of Matter in the production and preſervation of a ſpherical figure, as that of the ſeveral Globes is, beſides what hath been before ſuppoſed, it may be collected from the ſpherical figure which moſt Fluids take, when there is no obſtacle to hinder their doing ſo. Thus I have ſaid *Quick ſilver* manifeſtly doth, eſpecially in ſmall drops or quantities; in which caſe their own ſelf attracting power is equal to, or exceeds that of the earth: ſo doth Lead and other Metals when in fluxion (1); ſo doth Water, Oyl, and

(1) This is very manifeſt from the making of *Shot*. The way of doing which, is by running in

in ſhort all Liquids, which run nearly into a ſpherical form, when hung on a ſmall ſurface, as at the point of a Pin; or into an hemiſpherical figure, on a broader ſurface; their Self-Attraction cauſing the former, as that of the Earth and the Surface on which they lye doth the latter. Theſe Phænomena have indeed been aſcribed to divers Cauſes, moſt of them improbable enough, except the Preſſure of the incumbent Air: but this is manifeſtly not the true Cauſe, by reaſon the caſe is the very ſame in the *Air-Pump* (when the Preſſure is taken off) as in the free

ning the melted Lead through a Ladle full of holes into cold water. In doing which they take care their Lead be not too hot, becauſe the globules would then fly to pieces; nor too cold, becauſe it would then be long and have tails; but in a due temper it turns round. They put *Orpiment* into their Lead, when they melt and prepare it for Shot.

Air:

Air; and therefore ſome other Cauſe is to be found: and what more probable, or ſo probable as this of *Gravity* or *Attraction*, which manifeſtly exerts itſelf in ſome, and is highly probable in all material things? (2) In the Earth it ſelf there is manifeſtly ſuch a thing as *Gravity*, which might as well be the Natural Cauſe of the Sphericity of our Globe, as it is in that of leſſer Maſſes, but then, as I demonſtrated in the laſt Book, it is alſo evident, that an over-ruling Power, and a wiſe Providence not only gave Matter this Gravitating power, but guided and managed it in the formation of the World.

And now upon ſuppoſition that *Gravity* had any thing to do in the

(2) For the Proof of this I ſhall refer to Sir *Iſaac Newton's Opticks*, Queſt. 23. and in his *Principia* in many places, particularly L. 3. Prop. 5, 6, 7.

pro-

production of this Spherical Figure I am ſpeaking of; the ſame it muſt have alſo in the conſervation of that Figure. For the ſame Power it exerted at firſt, it retains ſtill; which is as neceſſary ſtill to the preventing and obviating all extravagant Excurſions, and Deviations from that figure, which may happen through extraordinary Commotions and Convulſions in any of the Globes; ſuch as Earthquakes are, and other ſuch like furious Concuſſions and Emotions that ſometimes befall our own Globe.

But leaving theſe conjectural matters, let us come to a more evident benefit of *Gravity*, and that is the natural tendency of all bodies to the center of the Globe: This is very manifeſt in our own Globe. For whatſoever the Decays are among earthly things, howſoever their Forms are changed, yet their *Matter* remaineth entire, and returneth again to its

grand Parent the Earth: or to put it in *Solomon*'s words, *Eccl.* 1. 4. *One generation passeth away, and another generation cometh: but the earth abideth for ever.*

AND an admirable proviſion this is for the perpetuity of the Globe, and to continue the State and Habitability thereof throughout all ages, which would otherwiſe waſt and decay, or run into the moſt irreparable and pernicious diſorders.

CHAP. II.

The Guard which Gravity affords againſt the Centrifugal Force of the ſeveral Globes.

UPON a ſuppoſition that every of the Globes revolves round its own Axis (which I have ſuf-

ſufficiently proved in the Fourth Book) we ſhall find, beſides the Benefits already ſpecified, another very great uſe of Gravity to the Good, yea the very Exiſtence, of our own and the other Globes, and that is the preſervation of their Integrity againſt the *Centrifugal force* of this their Revolution, or Diurnal motion. For without ſuch a Band, as Gravity, to keep their parts together, the whirling about of thoſe Globes would ſhatter them into pieces, and diſſipate them abroad into the circumambient ſpace. Thus muſt it needs befall our own Globe, which whirls about at the rate of above 1000 miles an hour (1), and is compoſed of Earth and Water, materials of much too looſe a

(1) The Diameter of the Earth being 7967,7 miles, according to B. 1. Ch. 2. Note 1. the Ambit thereof is 25031,4 miles, which being divided into 24 hours makes the Revolution to be at the rate of 1043 miles an hour.

texture to prevent the diſſipation which the Centrifugal force of ſuch a Rotation muſt neceſſarily occaſion about the Æquatorial parts, a Rotation that would as eaſily throw off the parts of the Earth, eſpecially the Waters, as the whirling round of a Wheel or a Globe, would the looſe Duſt and Water lodged thereon. But by reaſon the *Gravitating Power* exceeds the *Centrifugal* as 2174 exceeds 7,54064 (2) that is above 288 times, therefore all parts lye quiet and ſecure in their reſpective places, and enjoy all the benefits, which I ſhewed do accompany this Motion without any diſturbance from it.

Thus is our own Globe guarded by its *Gravity* againſt the *centrifugal force* of its *Rotation*. But this is far

(2) This is the proportion or nearly ſo, of the *Gravitating* to the *Centrifugal Force* of the Earth under the Equator, as may be computed from Sir *Is. Newton's Princip.* L. 3. Prop. 19.

more

more remarkable in some of the other Globes. Thus particularly in the Sun, whose Ambit is 2582873 miles, and whirls round once in about 25$\frac{1}{4}$ days, doth consequently revolve at the rate of 4262 miles an hour (3), above four times as fast as the Earth; which in a little time would endanger its dissipation, without such a provision as Gravity is.

But what is this to the Centrifugal force of *Jupiter*? whose Bulk far exceeds our terraqueous Ball, and whose Rotation is performed in less than half the time. But from a computation of particulars we shall better estimate the Matter. The Diameter

(3) The Sun's Diameter being 822148 miles, the numbers here assigned will naturally follow.

As to the Sun's *Gravity* or *Attractive Power* it is (by the calculation of my Friend, the acute and learned Dr. *Halley*,) to the Sun's *Centrifugal Force*, as 47000 to 1: The method for finding which see in Note 5.

of *Jupiter* being 120653 miles, its Circumference is 379045 miles: which revolving round in less than Ten hours, is at the rate of 38159 (4) miles an hour under its Æquator. And if the Density of every Planet be proportional to its Distance from the Sun, as is now with great reason imagined, that is, if those Planets nearest the Sun, as *Mercury* and *Venus*, are proportionably denser than those more remote, as *Jupiter* and *Saturn*; then is the Globe of *Jupiter* of a laxer texture than ours is, and in so much the greater danger therefore of being

(4) *Jupiter*'s Ambit being 379045 miles, and his Revolution 9 h. 56′ or 596 minutes; the Revolution in an hour is by the Logarithms thus.

596 minutes	2.7749463
379045 miles	5.5786942
:: 60 minutes	1.7781513
	7.3568425
38159 miles	4.5815962

whirl'd

whirl'd to pieces by ſo rapid a motion as that Planet manifeſtly hath, were not its parts kept cloſe together and ſedate by ſuch a Band as Gravity (5) is.

(5) The Proportion of *Jupiter*'s or any other *Planet*'s, or the *Sun*'s *Gravity* to their *Centrifugal force* may be computed from the moſt ſagacious Sir *Is. Newton*'s *Princip.* L. 3 Prop. 8 & 19. But the before commended *Savilian Profeſſor* ſuggeſted to me this eaſier and quicker Rule, for ſuch Planets as have Satellites, *viz. The Proportion of the Centrifugal to the Centripetal force, or Gravity of any Planet at its Surface, is compounded of the Ratio which the Cube of the Semidiameter of the Planet hath to the Cube of the Diſtance of any of its Satellites from the Center of that Planet; and the Ratio which the Square of the Satellites Periodick time hath to the Square of the Periodick Time of the Planet's Revolution.* Thus for inſtance, the diſtance of *Jupiter*'s *Outermoſt Satellite* being 23 Semidiameters of *Jupiter*; and it's Period 16 days, 16 hours, 32 minutes or 24032 minutes, and *Jupiter*'s Revolution 596 minutes; we ſhall find the Gravity in *Jupiter*'s Surface to be to his Centrifugal Force in his Equator, as 1 to 9,96.

CHAP. III.

Of the Power and Uſefulneſs of Gravity to retain the Planets in their Orbits.

FOr a Concluſion of this ſixth Book, I ſhall take notice of one more remarkable benefit of *Gravity*, which is grounded upon the ſuppoſition of the truth of the *Newtonian Philoſophy*; which hath ſo good Grounds, and great Reaſon, I might ſay Demonſtrations, on it's ſide, particularly in this matter, that admitting of it here, we ſhall diſcover a another admirable work of the Creation, and that is, the preventing the Evagation of the Planets, and the accurate Retaining them within the due Bounds of their Orbits. That this is done by *Gravity*, and that

Gravity

Gravity and *Motion* ſolve, in the moſt compleat manner, all the Phænomena of the Planetary Motions both Primary and Secondary, is abundantly made out by the wonderful Sagacity of the great Sir *Iſaac Newton*; as may be ſeen in his *Principia*.

But before I come to the particular agency of Gravity, it will be neceſſary to premiſe ſomething concerning its Nature, and ſome of its Properties, *viz.* That Gravity is not terminated at the Surface, but reaches to the very Center, and is extended to immenſe diſtances all round the Centers of all the Globes: By which means the celeſtial Bodies are enabled to have Syſtems of leſſer Globes revolving about them. For had the force of Gravity determined at, or near the Surface (as it might have done, if intended only for the Conſervation of the Globes) in this caſe, all the Bodies that were put

in Motion, and that were to paſs at ſome diſtance from them, would move on in a ſtrait, not curved line, and be loſt in the great Abyſs of Space. But the allwiſe CREATOR hath, in his firſt Production of Matter, beſtow'd upon it ſuch a Property, as that every Particle thereof hath a Tendency towards every other Particle. From whence it comes to paſs that every Body hath a *Gravitating Power* according to the ſolid Content or real Quantity of its Matter, and not according to its Superficies, or Extenſion.

And this *Gravity* of all Bodies is obſerved, manifeſtly to decreaſe in proportion of the ſquare of their Diſtances reciprocally; that is, at twice their diſtance the Force is but one fourth of what it was at a ſingle diſtance; and but a ninth at thrice the diſtance, &c.

That

THAT this is ſo, is abundantly proved by the laſt commended Author; who by eſtabliſhing this one Principle in Philoſophy, hath fully explain'd the Syſteme of the World, ſo far as relates to us, and to all the reſt of the Planets, that regard the Sun as a Center, both Primary and Secondary.

WHAT the Cauſe of Gravity is, Sir *Iſaac Newton* doth not pretend to aſſign, his deſign being not to engage himſelf in framing *Hypotheſes*, but to explain the *Phænomena* by *Experiments* only, and to raiſe his noble Superſtructure upon them. And therefore, although the matters of Fact, and the Final Cauſes are evident, I will not venture to ſay how it comes to paſs, that Bodies act at ſuch immenſe diſtances upon one another; but chuſe rather to acquieſce in adoring the Wiſdom and Power of the GREAT AUTHOR

of all things, who hath inſpirited the Materials, of which the World conſiſts, with ſuch an active quality, as ſerves not only to preſerve the Globes themſelves intire, but to enable them to revolve about their luminous Center (from whence they have their Light and Heat) in Orbs that are the moſt commodious, and alſo fixt and permanent.

HAVING thus premiſed what was neceſſary for the underſtanding the Nature and Properties of Gravity, I ſhall proceed to conſider its agency in the Planetary Motions. And here we have divers things, which plainly demonſtrate theſe Motions to be no matters of *Chance*, but the Works of an infinitely *Kind*, as well as *Omnipotent* and *Almighty Agent*.

I have already in Book 4. Ch. 2. taken notice of the Motion of the Planets being made not in Lines tend-

tending from the Center to the Circumference, or very obliquely thereto, but acroſs, or nearly perpendicular to the *Radii*. Alſo that the Motions and Orbits of the Planets do not tend contrary ways, or much interfere with one another. That therefore which I ſhall ſpeak of here, concerning the Planetary Motions being the Work of God, will be only ſo far as Gravity is therein concerned. And

1. It was a very notable proviſion to prevent the Evagation of the Planets, and to keep them within their due and proper Bounds, to bridle and detain them with Gravity, as with ſo many Roins and Bridles. For as the natural tendency of all Impreſt Motion is in Strait Lines, ſo when Motion was given to the Planets, this Motion (altho' as I ſaid it was artificially made, perpendicularly to the *Radii*, yet) would carry them

them quite away in their Tangents, ſo that they would never return again. But being thus detain'd by Gravity, another admirable proviſion is that, 2. They are moved in Orbs: Which Orbs are formed of a Motion compounded of this Rectilinear Impulſe impreſt upon the Planets, and the tendency of their Gravity to their Centers. In which Motion a 3d thing very remarkable is, That the Impulſe or Velocity which is imparted by the *Firſt Mover* to every Planet, and the Gravity of each Planet, are ſo nearly equal to what is required to make a Body deſcribe a Circle, that the Orbits of the Planets are not very Eccentrical, but nearly Circular. As is particularly remarkable in *Venus*, and the *Earth*; and more eſpecially in the whole Syſteme of *Jupiter's Satellites*. And an admirable Work this is. For ſhould the Velocity of any Planet be double to

what

what would make it move in a Circle, that Planet would go away *in infinitum*, without ever returning again in any Orb whatſoever. Or ſhould one half of the Velocity be taken away, the Planet would deſcend obliquely towards the Sun, until it became four times nearer the Sun than before; and then aſcend again to its former place, deſcribing a very eccentrical Orb. And by aſcending and deſcending alternately, it would be heated ſixteen times more at one time than another. Which uneven Heat would make the Planet unfit for Habitation. And the ſame thing would happen, if the determination of its motion ſhould be altered, ſo as to become very oblique to the *Radius* drawn from the Planet to the Sun. But theſe things being accurately adjuſted, and contempered, make the whole Syſteme to be a work of incomparable Convenience and Beauty;

Beauty; a Work the beſt contrived for the benefit of the World's Inhabitants, and to ſet forth the Curioſity and Skill of the infinite Workman.

It is manifeſt therefore that the Syſteme of the Planets is not to be reckon'd a matter of *Chance*, or a thing owing to a *Neceſſity of Nature*, but the Work of a kind and wiſe Agent. And that this is ſo will be farther manifeſt from the caſe of *Comets*, whoſe Motions, Directions and Orbs being utterly different from thoſe of the Planets, demonſtrate the *Planetary Syſteme* to have been modelled by *Counſel*, and not by a *Neceſſity of Nature*, or left to *Chance*. For as for the Motion of Comets, it is ſo far from being always the ſame way, that they move ſometimes contrary to one another. And as for their Planes and Directions, they lie every way. And as for their Orbs, they

are

are exceedingly eccentrical. And by the bye, this Eccentricity is an admirable Contrivance of the CREATOR, to prevent the Comets from disturbing either the Planets, or one another, by their mutual Attractions. For by this means, they have a large and sufficient room to revolve in; and by ascending to very great heights above the Systeme of the Planets, and spending almost all their time in the remote regions of the Universe, at vast distances both from the Planets, and from one another, they do not incommode either the Planets, or themselves; as otherwise they would have done, should they have moved in the same Plane with the Planets. For had they done so, they would have been apt sometimes to have come too near the Planets, and have disturbed their Motions, and perhaps have dash'd upon them also. But all these circumstances

are

are so well adjusted, and so wisely regulated by the Divine Providence, that the Systeme could not have been better contrived, either for convenience or beauty.

And now upon this highly probable, I may say Physically certain, Theory of Gravity acting in the Motion of the Globes, we have another exquisite Nicety in the Works of the Creation, that justly deserves the greatest admiration and praise. That among so many immense, moving Masses, they should all observe their due Bounds, keep the most proper Paths appointed for their convenience and good, and at all times answer the great Ends to which they minister in the Creation. Particularly that the *Habitable Globes* should always remain at such due Distances, and move in such proper Orbits, as are best for them. And that the *Comets* too should at the same time

pass

paſs in paths utterly different, but yet ſuch in all probability, as may render them alſo of very great uſe to ſome or other parts of the World; whether we look upon them as Places of Torment (as hath been ſaid) or Bodies appointed for the Refreſhment and Recruit of the Sun, or any of his Planets, as Sir *Iſ. Newton* conjectureth in his *Princip. L. 3. Prop.* 41 & 42.

AND now from the conſideration of what I have ſhewn in this ſixth Book to be either highly probable, or very certain concerning *Gravity*, we have another manifeſt demonſtration of the infinite *CREATOR*'s Wiſdom and Care, and another cogent argument to excite the higheſt Veneration and Praiſe in his Creatures.

BOOK

BOOK VII.

Of the Proviſion made for *LIGHT and HEAT* throughout the Univerſe.

CHAP. I.

Of the Light and Heat of the Fixt Stars and Sun.

AS *Light* and *Heat* are two of the moſt uſeful things in the Univerſe, ſo the infinitely wiſe and kind CREATOR hath made an excellent proviſi-

vision for these things, in all probability for every Globe throughout the Universe, but particularly for those of our own Systeme. For it is very manifest that every Globe we see doth shine with its own native, or with borrowed Light. Even all those immense Bodies at the greatest distance from us, the Fixt Stars, which I have before said are probably so many Suns, it is Light they manifestly dart as far as to our so distant Globe, as well as what they emit for the enlightening, warming, and cherishing their own respective Planets.

But I shall forbear to launch out into those conjectural matters, and shall come nearer home into our own Systeme, where we have enough to entertain our Eye, to captivate our Thoughts, and to excite our highest admiration of these magnificent Works of God; whether we survey the great Fountain it self of our Light and Heat,

the Sun; its due Poſition, and its wonderful uſe to its Planets; and the incomparable proviſions that are made to ſupply its abſence and greater diſtances from them.

AND in the firſt place, as to the *Sun* it ſelf; what Power is there that the moſt extravagant Phancy can imagine to it ſelf, that could ever be able to make ſo prodigious a maſs of Fire as the Sun is, but only the *power of God's Almighty Hand!* a Body of ſo immenſe a Bulk as I have ſhewn it is, and of ſuch an exceſſive Heat, that no greater a number of its Rays than what fall within the compaſs of a two or three inch Burning-Glaſs ſhall actually burn; and what fall within the compaſs of not many feet, ſhall far exceed the ſtrongeſt culinary Fire in the Earth; as is manifeſt from its almoſt inſtantaneous burning, and vitrifying the moſt obdurate incombuſtible bodies, ſuch as not only green

green wood, and white bodies, but alſo Stones, Bricks, Metals, yea Gold it ſelf (the hardeſt of all metals to be wrought upon by fire) which yet is melted down in a few minutes (1).

Thus the *infinite Power and Wiſdom of GOD* appear in the appointment and make of that immenſe Body of Fire, the Sun; a maſs wonderful, and worthy of its Maker, whether we conſider its immenſity, its ex-

(1) The famous *Burning-Concave* at *Lyons* of 30 Inches Diameter, and others in *France* and *Germany* of greater breadths, have been celebrated for their Feats in burning, calcining and vitrifying both metallick and other Bodies. But I queſtion whether any of them have come up to the Burning Inſtrument contrived by, and made for Sir *I. Newton*, and by him preſented to the *Royal Society*. It conſiſts of 7 Concave foiled Glaſſes, each of them 12 inches diameter: which are all ſo placed as to have their *Foci* concur in one point. By which means the Heat is ſo increaſed, as in a ſurprizing manner to perform the Feats here mentioned, and many others ſurpaſſing them.

ceſſive Heat, or its abſolute neceſſity and great uſe to us; and all the reſt of its Syſteme. But we ſhall find yet farther evidences of the great CREATOR's work in the following Chapter.

CHAP. II.

Of the due Poſition and Diſtance of the Sun and its Planets.

AS the infinite Power and Wiſdom of God appear in the appointment and make of the Sun, according to the preceding Chapter; ſo in this I ſhall demonſtrate the ſame from the due Poſition of the Sun among his Planets, and his due Diſtance from each of them.

NOw here we may take it for granted that the Sun is the Fountain of

of the Light and Heat of all the Planets, not only of the Earth, but of the other Planets too, that move either about the Sun, or the Earth, but whether the Sun be placed in the Center of its Syſteme, or the Earth be ſo, is of no great conſequence here to enquire. But I have all along ſuppoſed the former to be the moſt probable Hypotheſis, and it ſeems to be ſtill more ſo from the conſideration we are now upon, concerning the community of its Light and Heat to all the Planets. For ſince it is manifeſt that what Light and Heat the Planets have, they receive from the Sun, it is far more likely that this their Fountain of Light and Heat is placed in the common center of them, and that they move round about it, rather than it about them.

But be it ſo or not ſo, it is however very certain that all the Planets are placed at ſuch a due and proper

Diſtance from the Sun, that they receive the beneficial Rays thereof in a due manner and proportion. There is no great reaſon to doubt of this among the Planets that are at greater or leſſer diſtances from the Sun than we, becauſe we find ſo noble and ſolemn an Apparatus anſwerable to their diſtances from the Sun, which I intend to ſpeak of hereafter. But as for our own terraqueous Globe we have ſufficient ſignals of the great care and counſel that have been uſed in the due *Poſition* and *Diſtance* thereof from the Sun. For as to its *Poſition* to the Sun, I have heretofore ſhewn, that by the Inclination of its Axis, and its Diurnal and Periodical Revolutions, all parts have a due ſhare of Light and Heat. And as for its *Diſtance*, it is ſuch as not only prevents the danger of its interfering with the other Globes, as I have formerly obſerved, but alſo it is duly adjuſted

to

to the Denſity of the Earth and Waters, and to the Make and Temper of our Bodies, and of all other things here below. Had we been much nearer the Sun, our World would have been burnt up and waſted, the Waters in the firſt place would have all been turned into vapours, and dried up; Vegetation have ſoon ceaſed, and all things would have ſoon been waſted, if not burnt and conſumed. Or had we been not at ſo very great a diſtance, but only a little nearer the Sun, as ſuppoſe a few thouſands of miles, ſtill the Heat would be as the ſquare of the diſtance (1); and conſequently too great, if not for the Polar, yet for the Æquatorial parts. And on the contrary, had we been ſet at a greater diſtance from the Sun, ſo would the Sun's Heat have been

(1) *Newton. Princip. P.* 466.

abated in proportion to the ſquare of that diſtance. And in this caſe, if the diſtance had been very great, we and all things muſt have been perpetually frozen up; or if it had been not ſo great, the world would have ſuffered by cold, the Polar at leaſt, if the Æquatorial parts ſhould eſcape.

AND in this caſe, when our Globe ſhould thus be parched up with everlaſting Heat, or be everlaſtingly frozen with exceſſive Cold; inſtead of an habitable, pleaſant, and comfortable World, it muſt become a Deſart, a place of irkſomneſs, miſery, and everlaſting puniſhment. But the *great* CREATOR having ſo wiſely and indulgently ordered the diſtance between the Earth and Sun, the Sun's Light and Heat are incomparably accommodated to the ſtate and temper of all things here below, and our World is well fitted for habitation, well provided with every thing that may

miniſter to the ſupport, the comfort and pleaſure of its Inhabitants. By thoſe indulgent Rays all things are enlightened, and we and all the reſt of the Animal Kingdom are enabled to diſpatch our buſineſs, to ſeek and provide our Food, and to paſs from place to place, as our occaſions or pleaſure lead us. By its cheriſhing Beams all things are warmed and comforted, Vapours in ſome meaſure made to riſe for the forming of Clouds and Rain; Trees and Plants are enabled thereby to put on their verdure and gaiety, and to yield us the benefit and pleaſure of their Grain and Fruit. By the preſence of this great fountain of Light and Heat, we and even Nature too is awake and excited; and by its abſence grows torpid and dull: its abſence by Night diſpoſes us to reſt and ſleep; and even Vegetables too ſhut up their Flowers

ers then (2) and in a manner betake themſelves to reſt: and its abſence in Winter how doth it change the whole face of Nature, diveſt Vegetables of their gay attire, force Animals to places of ſhelter and ſafeguard, and give an aſpect of melancholy and horrour to all things!

Thus it is manifeſt how wiſely and indulgently the *great* CREATOR hath provided for the good of our Planet, by ſo critically adjuſting its Poſition to, and its Diſtance from the Sun, to the ſtate and temper of it and all things thereon. And although the reſt of the Planets encompaſſing the Sun are ſome of them nearer to, ſome of them farther from it, yet there is no great queſtion to be made but the ſame wiſe Contriver hath made as good a proviſion for

(2) See my *Phyſico-Theol.* B. 10. *Not.* 14.

them

them as for us, either by contemperring their Denſity to their Diſtance from the Sun, or by ſome other the wiſeſt and beſt courſe; as we have very juſt reaſon to ſuſpect from that grand and ſolemn apparatus I ſpake of, of Secondary Planets. Which leads me to conſider the Proviſions made for the ſupply of the Sun's abſence, and greater diſtance.

CHAP. III.

The Neceſſity of Light, and the Proviſion for it by the Atmoſphere.

BEFORE I come to the other Planets, it will be convenient to conſider how the Sun's abſence is ſupplied here upon the Earth, as alſo probably how it is ſupplied in her concomitant the Moon.

AND

And firſt as to the Earth. Of ſuch abſolute neceſſity is *Light* (not to mention Heat) that our World could not well be in the leaſt utterly without it, becauſe during utter, abſolute Darkneſs (beſides the great inconveniences it might bring to Vegetables, Minerals, and every other ſuch like part of the Creation, beſides this I ſay) it would certainly put Animals under an utter incapacity of performing their moſt neceſſary buſineſs, and acting in that office which the divine Providence hath appointed them, although of greateſt uſe to themſelves or the reſt of the World. Men, for inſtance, whoſe buſineſs and occaſions oftentimes neceſſitate them to borrow a part of the Night; and other Animals, whoſe Safety or Temper, or Conſtitution of Parts (as of their Eye, or ſome other parts) confine them to their Dens, and places of retirement and reſt by Day,

and

and are therefore in course compelled to seek their food, and wander about on their most necessary occasions of life by Night, all these, I say, would at once be cut off from one of the grand benefits of life, from acting that part they bear in the Creation, during such time as they should be put into absolute Darkness. But to prevent this, the infinitely wise *Contriver* of the World hath made divers admirable provisions both in our own, and the other Planets too. One provision which he hath made in our own Globe, and I may add that of the Moon also, is by encompassing both with an Atmosphere (1),

(1) Mr. *Hugens* in his *Cosmotheor.* p. 115. concludes the Moon to have no Air or Atmosphere because we see its Limb so clearly and accurately defined, and because he thought there are no Seas or Rivers in the Moon. But he was mistaken both in his Conclusion and part of his Premises. For in the Solar Eclipse

which

which, among other grand uſes, miniſters very much to the propagation of Light, partly by reflecting the Rays of Light to our Eye, and partly refracting them ſo as to make them viſible and uſeful to us, when otherwiſe they would not appear. Hence that Whiteneſs (2) and Brightneſs obſerveable in the air by day; and hence the Twy-light, when the Sun is hidden under the Horizon. The like to which is obſerveable in the Moon alſo, in that ſecondary, ruſty light which is ſeen in her Eclipſes, and before and after her Quarters.

May 1. 1706. which in *Switzerland* was Total, they could manifeſtly perceive the Moon's Atmoſphere, as may be ſeen in the Accounts given in *Philoſ. Tranſ.* No. 306.

(2) See *Phyſico-Theol.* B. 1. Ch. 1. Note 12.

CHAP.

CHAP. IV.

The great uſefulneſs of the Moon, and the mutual beneficial Returns which the Globes make to one another.

HAVING ſhewn the abſolute neceſſity of Light, and the ſupply thereof by the Atmoſpheres; let us next ſpeak of the principal proviſion made for that, and for ſupplying the Sun's abſence, and that is by the *Moon* and *Stars*, which as *Moſes* ſaith (1) *rule the Night*, as the *greater Light*, the Sun, doth *rule the Day*. What influences theſe celeſtial Bodies may have here below in the bodies of Men and other Ani-

(1) *Gen.* 1. 16.

mals,

mals, or among Vegetables, Foſſils, or in any of the grand works of Nature, is hard to determine, although vainly pretended unto by the judicial Aſtrologers: but yet ſome things there are whoſe Periods and Criſes ſo ſtrictly obſerve the Courſes of the Sun, eſpecially of the Moon, that, on the other hand, it is hard to deny the influences of theſe Bodies here below. The *Tides* particularly have all along ſo conſtantly obſerved the Courſes of the Moon, that in all ages they have been ſuſpected to be cauſed and governed by that Planet; and if the ſtories of *Pliny* (2), *Ariſtotle*, and others of the Ancients be true, it is by her influence that the bodies of Oyſters and other Shell-fiſh are increaſed and diminiſhed; that the maſs of man's Blood is ſo

(2) *Plin. Nat. Hiſt. l.* 2. *c.* 41, 98, 99, 101.

alſo

alſo; that the Humours are reſolved and attracted, that the Dead bodies of Beaſts are corrupted, that all Animals expire at the time of Ebb, particularly man; that the Sea purgeth it ſelf of filth every Full-moon, which gave occaſion to the fable of the Sun's having his Stable about *Meſſina* and *Milazzo*; and divers other ſuch like conceits which thoſe Authors name, too many and too improbable to deſerve to be reckoned up in this place.

But whatever influences the Moon may have upon things here below, whatever her concern may be in any tranſaction of Nature, or any other office of the Creation, it is however very certain that her *Light*, *Eclipſes*, *Monthly Revolutions*, and *Latitude* or Vagations towards our Poles, are of great uſe to us.

By her *Light*, to which I may add that of the *Stars*, we and the reſt of

the Creatures are able to protract our day at pleaſure, to go hither and thither as our occaſions call, and to diſpatch many of our affairs by Night, or to betake our ſelves to Repoſe and Reſt, to which, according to *Pliny* (3), the Moon doth naturally incline us.

As to the *Eclipſes*, whether of the *Sun* or *Moon*, they have their excellent uſes too. The Aſtronomer applies them to conſiderable ſervices in his way; and the Geographer makes them no leſs uſeful in his; the Chronologer is enabled by them to amend his accounts of time, even of the moſt ancient days, and ſo down through all ages; and the Mariner too can make them ſerviceable to his

(3) *Ferunt Lunæ fœmineum ac molle Sidus, atque nocturnum, ſolvere humorem, & trahere, non auferre. Id manifeſtum eſſe quod* ——— *Somnus ſopitis ſorporem contractum in caput revocet.* Plin. L. 2. c. 101.

purpoſe,

purpose, to discover his Longitude, to correct his Account at Sea, and thereby make himself more secure and safe in the untrodden paths of the Deep.

So for the *Monthly Revolutions* of the *Moon*, besides the uses they have in the daily Variations of the Tides, and perhaps causing some such Revolutions too in the Humours and Bodies of Animals, and in the works of Nature, besides this I say, they are manifestly of excellent use in the Divisions of Time, in measuring out our Months, as the Sun doth our Days and Years, according to that appointment of the Creator, Gen. 1. 14. *And God said, let there be Lights in the Firmament of the Heaven, to divide the Day from the Night; and let them be for Signs, and for Seasons, and for Days and Years.*

And lastly as to the Lunar *Latitude*, or Progresses towards our Poles,

beſides the uſe hereof to the preventing the too frequent Eclipſes of the Sun and Moon, thoſe Vagations are of great uſe to the Polar parts of the World, in affording them a longer, as alſo a ſtronger and better light, than if the Rays fell more oblique: which muſt needs be a very great comfort, and of wonderful ſervice to the Inhabitants of thoſe forlorn parts, in their long and tedious Nights of ſome days, yea ſome months length: to Men, to enable them to diſpatch ſuch of their Affairs as are of perpetual and conſtant neceſſity; and to other Animals of the Air, Land, or Waters, to enable them with greater eaſe and pleaſure to get their Food, and paſs where their pleaſure leads them.

Thus the *great* CREATOR hath made the Moon to be of admirable uſe to our Earth. And ſo wiſely hath he contrived his Works, that

that they are mutually ſerviceable to one another, ſo that what good ſervices one doth, the other as readily returneth again. Thus as the Moon is a Moon to us, ſo the Earth is with great reaſon concluded by the Philoſophers to be a Moon to the Moon; not indeed a Secondary Planet moving periodically about her, but ſuch a Planet, as reflects the Light of the Sun to her, and perhaps makes ſuch like returns of Influx as I ſaid the Earth receives from her. For it is not to be doubted, if the Earth reflects light, and gravitates to the Moon, as well as the Moon to the Earth (which is highly probable) but that there is a mutual intercourſe and return of their Influences, and good Offices. And this is ſtill more probable from the likeneſs diſcernable between the Earth and the Moon, which is a ſtrong preſumption that the Moon may have the ſame occaſions for the

Earth, as the Earth for her. For that ſhe is an opake body, and that her ſurface is covered in ſome meaſure, with Hills and Valleys, is manifeſt beyond all doubt to our Eye (4), as I before ſaid: and that ſhe hath an Atmoſphere is what hath been not long ſince (5) diſcovered: and that there are large Oceans and Collections of Water is what I have before made probable (6). And therefore agreeing thus in Conſtitution and Make, their Occaſions for, and Influences upon each other are in all probability mutual, and much the ſame.

AND after this manner the infinitely *wiſe Contriver* of the Univerſe, ſeems to have tranſacted throughout that immenſe ſpace, by making all the ſeveral Globes uſeful to one

(4) See Book 5. Chap. 2. Note 1.
(5) See before Chap. 3. Note 1.
(6) Book 5. Ch. 4. Not. 1. as alſo the Preface

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another. Thus all the Planets of our Solar Syſteme are of conſiderable uſe to us, all of them reflect Light unto us, and ſome of them a Light ſo bright and ſtrong, as particularly *Venus* and *Jupiter*, that they are a good ſupply of the Moon's abſence in the night as well as the Sun's. Nay the very *Secondaries* (which I ſhall ſhew are of greateſt uſe to their Primary Planets,) have their uſes too amongſt us; not only as being evident demonſtrations of the great Works of God, but alſo in miniſtering to the diſcovery of the Longitude of the moſt diſtant Places upon the Earth. So for the *Fixt Stars* which I have before ſhewn to be probably ſo many Suns miniſtering to as many Syſtemes of Planets; it is certain they are of great uſe to us in ſupplying the abſence of the Sun and Moon by night. And there is no great doubt to be made, but that the like Returns are

made to them and their Systemes by our Sun. So that here we have an admirable Oeconomy observeable throughout all the visible regions of the Universe, in the mutual Assistances and Returns which one Globe affords the other even at the greatest Distance.

CHAP. V.

Of the Moons, or Secondary Planets in general, which are observed about some of the Primary Planets.

HAVING taken a view of the methods which are used for the accommodating the Earth with Light and Heat, let us cast our Eye to the rest of our *Solar Systeme*, and examine whether any thing of the like kind be to be found there. And here

here we ſhall find a no leſs admirable ſcene of the *great* CREATOR's Care and Wiſdom, than we diſcovered in the Earth and Moon. In *Mars* indeed, we can diſcern a great ſimilitude with the Earth in its Opacity and Spots, but we have not yet been able to perceive any attendance of Moons, as in the other ſuperiour Planets; not ſo much probably becauſe there are none, but becauſe they are ſmall, or they reflect a weak light, and are at a great diſtance from us. And as for *Venus* and *Mercury*, there may be no occaſion for any Attendants, by reaſon of their proximity to the Sun. But in the two higheſt, or more diſtant Planets, *Jupiter* and *Saturn*, we have a very noble and entertaining ſcene of the CREATOR's *Glory*. For whereas thoſe two Planets are at a much greater diſtance than any of the other Planets, from their Fountain of Light

and

and Heat, the Sun; and as conſequently their Heat and Light are abated in proportion to the ſquare of their Diſtances; ſo to make them amends they are ſurrounded with a more grand Retinue of *Secondary Planets*, or Moons; *Jupiter* with four, *Saturn* with five, as 'tis imagined, and probably more (1).

(1) Mr. *Hugens* in his *Coſmotheoros* p. 99. gives this account of the diſcovery of the Satellites of *Jupiter* and *Saturn*, That it is *well known the diſcovery of the Circumjovials is owing to* Galilæo; *that the brighteſt, and outermoſt Circumſaturnial he happened to ſee with a 12 foot Glaſs in the year* 1655; *that the reſt are owing to* Caſſini, *who firſt ſaw them with a Glaſs of* Campani's *grinding of 136 feet, and afterwards with one of as many feet above* 100. That *the 3d and 4th* Caſſini *ſhewed him in* 1672, *and afterwards oftener*. That Caſſini *acquainted him by Letter afterwards with his diſcovery of the firſt and Second in* 1684. That *thoſe two laſt are not eaſily diſcerned, and he cannot ſay he ever ſaw them*. That *beſide theſe 5, he ſuſpects there may be one or more lye concealed*. Of which ſee chap. 7. following.

AND

AND an admirable remedy this is, not only for the great diſtance of theſe two Planets from the Sun, but alſo for the tardity of their periodick motion in their reſpective Orbits. For whereas *Saturn* revolves round the Sun but once in near thirty years, and *Jupiter* but once in near 12, it comes to paſs that the places near the two Poles of theſe Planets have a Night of near 15 years in *Saturn*, and 6 in *Jupiter*, ſuppoſing their Axes inclined to the Planes of their Orbits, as it is in our own Globe. But ſuppoſing (as it is imagined) that their Axes are not ſo much inclined, and that their Days and Nights, their Winters and Summers are nearly equal; in this reſpect the caſe would be worſe than in the long Nights in the other caſe: but in both caſes the Polar parts of both thoſe Planets would be diſmal regions of darkneſs, when ſo long detained from the kindly

kindly visits of the Sun. But an admirable remedy is found, and a glorious scene of the great CREATOR's Works appears therein, as will be manifest by considering particulars in each of those two Superiour Planets.

CHAP. VI.

Of Jupiter's Moons, Days *and* Seasons.

IN speaking concerning the superior Planets in particular, I shall begin with *Jupiter*. The Distance of this Planet from the Sun, is reckoned to be 343 millions of miles farther from the Sun than we are; and by that means the Sun's Light and Heat are 27 times less there than with us, and its apparent Diameter five

five times leſs (x). And conſidering how vaſt a Globe *Jupiter* is, having its ſuperficies 100 times, yea (according to Mr. *Huygens*'s computations) 400 times bigger than that of the Earth; in this caſe, what vaſt tracts of that Globe muſt needs lie in profound darkneſs and deſolation, had no remedy been provided! But there are divers provided. One is by the frequent Rotations of *Jupiter* round his own Axis; which being performed in leſs than 10 hours, it comes to paſs that what is wanting in the ſtrength and degree of Light and Heat, is compenſated by the frequent Returns thereof.

The other Remedy is by the Increaſe of the number of *Moons* about

(x) *Gregorii Aſtron.* L. 6. Prop. 5. Mr. *Huygens* makes the Light and Heat but 25 times leſs and the apparent Diameter 5 times. *Coſmoth.* p. 103.

Jupi-

Jupiter, who is attended (as I ſaid) with four, as we, who are neareſt the Sun, are with one. Concerning which, theſe four things are remarkable.

1. Their Bulk, which in all probability is not in any of them leſs than our Earth, as the moſt ingenious Mr. *Huygens* concludes (2) from their ſhade upon *Jupiter's* diſk. By which means partly it is that

2. They reflect ſo ſtrong, briſk and vivid a light, as appears very illuſtrious and entertaining even to us at ſo great a diſtance from it: which cannot but be very pleaſing and comfortable to that Planet: beſides the no leſs beneficial and friendly Influences therewith conveyed at the ſame time.

(2) Coſmotheor. p. 101.

3. Their

3. Their due Diſtances from *Jupiter*, and from one another; and their agreeable periodick Revolutions which I have formerly obſerved (3) to be in the moſt exact mathematical proportions. By the firſt of theſe, thoſe Satellites eſcape all diſagreeable Concourſes and violent Oppoſitions, and, in the moſt kindly manner, ſend their Influx to the Planet they wait upon: and by the latter, they are perpetually carrying about their Light and other benefits from place to place. For by the motion of the Innermoſt round once in leſs than two days; of the next in about 3½ days; of the Third in ſomewhat above a week; and of the Outermoſt in near 17 days: by theſe means, I ſay, it happens very ſeldom that any part of *Jupiter* is at any time without the preſence and at-

(3) Book 4. Chap. 4.

ten-

tendance of one or more of those Satellites; but one is visiting one part, whilst another is attending another, and another another part, and *Jupiter* himself making speedy Returns and Revolutions all the while.

4. The last thing remarkable is the Latitudes of *Jupiter's* Moons, or their progresses to his Poles, which are in a due proportion to their Distances and Periods. The diligent and ingenious *Cassini* hath determined (4) the greatest Latitude of the Innermost not to exceed a 3d part of *Jupiter's* Semidiameter; that of the next about a quarter of his Diameter; that of the Third about three quarters of his Diameter (but I have my self observed it to be very nearly or altogether parallel with *Jupiter's* Poles)

(4) *Cassini's Les Hypoth. & Tab. des Sat. de Jupit. Sect.* 4. among the Tracts of the *Messieurs de l'Acad. Roy. des Sciences.*

and

and that of the Fourth or Outermoſt to go beyond the Poles of *Jupiter* a third part of his Semidiameter. By which means this Satellite eſcapes the Eclipſes of *Jupiter's* ſhadow for the ſpace of two years.

And as the Latitudes of theſe Satellites differ according to their Diſtances and Periods; ſo another remarkable thing therein, is, that they ſhift their Latitudes in longer or ſhorter times, agreeable to their greater or leſſer Latitudes; ſome making their progreſſes towards *Jupiter's* Poles one way, whilſt ſome are wandering the other way, and ſome ſtaying there a longer time, and ſome a leſſer and leſſer time. By which quadruple variety of Latitudes, and perpetual changes of it, it comes to paſs, that thoſe large tracts towards the Polar parts of that vaſt Planet, have their ſhare in the light and kindly ſervices

of the four Moons, and are ſeldom or never deprived of them.

CHAP. VII.

Of Saturn's Moons, Ring, Days *and* Seaſons.

HAVING ſeen the admirable proviſion made for the remedying *Jupiter's* great diſtance from the Sun; let us in the laſt place take a view of *Saturn*, which is above 200 millions of *Engliſh* miles farther from the Sun than *Jupiter*, and near 700 millions of miles father than is our Earth. And here our Glaſſes, as imperfect as they are, have diſcovered ſo ſurprizing an Apparatus, that muſt needs ſtrike every one that views it with wonder and amazement.

For

For, in the first place, instead of four Satellites or Moons, as *Jupiter* hath, *Saturn* is supposed to have five, and probably more. Three of these I my self have seen with Mr. *Huygens*'s 126 foot Glass; but for want of a Pole of sufficient height to mount the Glass high enough, I am not sure I have seen any more. And besides those Five which others have seen, there is great reason to conclude there is a *Sixth* lying between the two Outermost, there being a larger space between them than is in proportion to what is found amongst the rest. And it is not improbable but that there are others also lying beyond the Fifth or Outermost, but become invisible at so great a distance from us, by means of some obscurity, such as is observeable in the Outermost it self, which is never to be seen by us, but in the western part of its Orbit, as

Mr. *Huygens* well obſerves (1).

THESE Satellites we may reaſonably conclude to be of a prodigious bulk for the reflecting of Light, and for their other miniſtrations to *Saturn*, becauſe otherwiſe they could not be ſeen at ſo great a diſtance as the Earth; and particularly one of them (2) is of that magnitude, and its

(1) The reaſon why *Saturn*'s fifth *Satellite* appears not on the Eaſtern, but Weſtern part of its Orbit, Mr. *Huygens* very ſagaciouſly (like himſelf) conjectures to be, becauſe this *Satellite*, as the Moon doth to the Earth, always turns one and the ſame Side to *Saturn*, and becauſe this Satellite hath, he imagines, only one part of its ſurface clear, and the greateſt part obſcure, and not able to reflect ſufficient light to us, therefore all the time that obſcure part is turned towards us (which is whilſt the Satellite is in the Eaſtern part of it's Orbit) it diſappears: but in the Weſtern part it appears, becauſe the bright ſide lies towards us. *Coſmotheor.* p. 118.

(2) It is the fourth Satellite, or Outermoſt but one (called from its firſt Diſcoverer, the *Hugenian Satellite*) that is ſo viſible.

Light

Light ſo brisk and vivid, that it appears very illuſtrious through our longer Glaſſes, and may be diſcerned with our ſhorter.

As to the *Diſtances*, the *Periods*, and *Latitudes* of thoſe Satellites, they being conſentaneous to what I have already taken notice of in *Jupiter*, I ſhall not inſiſt upon them, but paſs to another proviſion made for the great diſtance of that Planet; which is a thing ſo ſingular to *Saturn*, ſo unuſual in all the reſt of the Creation, and ſo amazing, that it is an evident and noble demonſtration of the great CREATOR's *Art* and *Care*; and that is, *Saturn's Ring*. Concerning which, theſe things are obſerveable.

1. The prodigious *ſize* of it, its great breadth, and vaſt compaſs. This we may make a judgment of, by comparing it with *Saturn* himſelf. And ſuppoſing the Diameter of *Saturn* to be as is before determined, 93451

Engliſh miles, the Diameter of his Ring will be 210265 ſuch miles, and its breadth about 29200 (3), an amazing Arch to an Eye placed in that Planet.

2. The due and convenient Diſtance of it from *Saturn* it ſelf; not cloſely adhering to it, becauſe that would annoy a large portion of *Saturn*'s globe, by depriving it of the Sun's rays, but environing it about the diſtance of its breadth; by which means the Sun's Light and Heat are permitted to enter between the Planet and its Ring, whilſt other Rays are at the ſame time reflected upon the Planet by the Ring.

(3) Mr. *Huygens* in his *Syſtema Saturn.* p. 47. and *Coſmotheor.* p. 109. determines the Diameter of *Saturn's Ring* to the Diameter of *Saturn*, to be as 9 to 4; and the Breadth of the Ring, and Diſtance of the Ring from *Saturn*'s body, to be nearly equal, and accordingly theſe numbers are defined here.

3. The

3. The thickneſs of the Ring, which is hardly, if at all perceivable by us; which is as great a benefit, as its edgling ſhade would be an annoyance, was the Ring thick.

4. Its ſmoothneſs and aptitude to reflect Light and Heat (4) is a wonderful convenience in it. Was it full of Mountains and Valleys, and I may add Waters too, as in our earth, and probably the Moon likewiſe, the Reflections would be too weak to render the *Ring* viſible unto us, at ſo great a diſtance as we are; but perceiving its Light to be ſo lively and ſtrong, as to render both it ſelf and *Saturn* very illuſtrious, it is a demonſtration of the aptitude of its ſtructure, and ſmoothneſs for the reflection of Light and Heat to the Planet it ſerves.

(4) See *Hugen. Syſt. Saturn.* p 70.

5. As the Periodical Revolutions of the Earth are an excellent and providential contrivance for those useful and necessary mutations we have of the Seasons of the year, so no doubt but the same benefits accrue to those Revolutions which *Saturn* hath about the Sun. It is visible that as *Saturn* changes its place in its Orbit, so its *Ring* receives a variety of aspects (5), not only with respect to us, but to the Sun. Thus in one part of the Orbit it appears with a (6) larger Ellipsis, so as to exhibit

(5) Every 14 or 15 years *Saturn*'s *Ring* hath the same Face; appearing at one time with large open *Ansæ*, at another time with no *Ring* at all. Which Appearances it obtaineth by gentle progresses from the one to the other Face. As, if the *Ansæ* are at the largest, they gradually diminish, until no *Ansæ*, or *Apertures* are to be seen in the Ring, and at last no Ring at all also.

(6) This Mr. *Huygens* shews is when *Saturn* is 20 ¹ degrees in *Gemini* and *Sagittary*. This

a large ſpace between it and *Saturn*: in another part, with a leſſer, and ſo with a leſſer Ellipſis, and ſometimes as only a ſlender ſtrait line, and ſometimes it is not viſible at all (7): alſo ſometimes one ſide of the Ring is enlightened, and reflects light towards

was the appearance it had in the beginning of 1708. Of which I have given a Repreſentation in Fig. 7.

(7) Mr. *Huygens* ſhews that for about ſix months before and after *Saturn*'s being in 20 degrees of *Virgo* and *Piſces*, the Ring is not viſible, but *Saturn* appears round. *Syſt. Saturn.* p. 59, 74, *&c.* And accordingly at this very time there is no appearance of the Ring, only a ſmall narrow Liſt or Belt croſſeth the middle of *Saturn*'s Disk, of a colour ſomewhat different from the reſt of *Saturn*'s Face, and in the place where the Ring ſhould be. This appearance of *Saturn* is repreſented in Fig. 8. which is the appearance he had through a very good 34 foot Glaſs, at the latter end of *Octob.* and beginning of *Nov.* this preſent year 1714. But a little before this, *viz.* on *Sept.* 26. I could through an 126 Glaſs, diſcern the narrow ends of the Ring on each ſide *Saturn*. A repreſentation of which I have given in Fig. 9.

one

one part of *Saturn*, ſometimes the other enlightens another part; and there is no doubt but that as our Earth has its Seaſons according to its poſition to the Sun in its periodical motion in its Orbit; ſo *Saturn* throughout his Period, hath his Seaſons according unto his poſition to the Sun, and the various Reflections of the Ring upon the ſeveral parts of his Globe (8).

THESE five things obſerveable in *Saturn's Ring* we have pretty good aſſurance of from our Views through good Glaſſes. But there is a

(8) There is very great reaſon to imagine this doth certainly happen in *Saturn*, becauſe as Mr. *Huygens* obſerves, *Saturn* appears ſometimes more ſplendid than at other times. *Ita ſemper* (ſaith he) *quo propiùs verſus Cancri & Capricorni ſigna acceſſerit, eo majorem, aut certè ſplendidiorem, etiam abſque teleſcopio apparaturum, quippe Annuli ellipſi ſemper ſe latiùs pandente.* Hugen. Syſt. Saturn. p. 56.

6. Thing

6. Thing I ſhall add as only conjectural, and that is, A ſuppoſition that the Axis of *Saturn* (9) is inclined (and that pretty much alſo) to the plane of its Ring, or the Plane of its Orbit at leaſt; and that he hath a Diurnal Rotation in ſome certain ſhort ſpace of time. For without theſe two conveniences, very large tracts of *Saturn* would ſuffer extreamly for want of the Sun. For if *Saturn* hath no other motion but that round the Sun in its orb, one part muſt be excluded from the Sun's Viſits for 15 years, whilſt the other partakes all the while of them; and one Hemiſphere will enjoy the benefit of the Ring, whilſt the other is eclipſed by it: and in this caſe the Ring would

9 Mr. *Huygens* determines the Inclination of *Saturn*'s Axis to the Plane of his Orbit to be 31 gr. as that of the Earth is 23 *degrees*. *Coſmotheor.* p. 108.

be

be nearly as prejudicial to the eclipſed part, as it is uſeful to the enlightned. But ſuppoſing *Saturn* to move round in the ſame, or a ſhorter time than *Jupiter*, and in a path pretty much inclined to the Ring, all parts then of that vaſt Planet will have their frequent returns of Day and Night, of Heat and Cold. And ſince this is what is diſcernable in the other Planets, and is no leſs neceſſary for the benefit and comfort of this, we may reaſonably conclude the thing to be probable, although not diſcernable at *Saturn's* great diſtance from us.

CHAP.

CHAP. VIII.

The Conclusion.

THUS I have taken a View of the provision made for those two grand and universal Necessaries, Light and Heat; things, in all probability, no less necessary for the other Globes, than for our own; and things which not only Animals cannot subsist without, but what all things here below stand in need of as well as they. When therefore we actually see and feel those indulgent provisions, those amazing acts of the great CREATOR; when we have views of their extent into Myriads of other the most distant Globes; when (to go no farther) we see in our own Systeme of the Sun,

ſuch a prodigious maſs of Fire placed in the Center, to ſcatter away the Darkneſs, and to warm and cherish us by Day; and ſuch a noble Retinue of Moons and Stars attending and aſſiſting us by Night; when we ſee this *indulgence*, this *care* of the CREATOR extended to all the other Planets, and that, according to their ſeveral diſtances, they have a proportionate proviſion of the greater number of Moons, and *Saturn* a ſtupendous *Ring* beſides, to ſupply the decreaſe of Light and Heat; who can be otherwiſe than amazed at ſuch Providential, ſuch Uſeful, ſuch well Contrived, ſuch Stately *Works* of GOD! Who can view their Glories, and partake of their beneficial Influences, and at the ſame time not adore the *Wiſdom*, and praiſe the *Kindneſs* of their CONTRIVER and MAKER! But above all, ſhould there be any found among Rational Beings ſo

ſtupid,

ſtupid, ſo vile, ſo infatuated with their Vices, as to deny theſe *Works* to GOD, and aſcribe them to a *Neceſſity of Nature*, or indeed a meer *Nothing*, namely *Chance*! But ſuch there are to be met with among our ſelves, and ſome ſuch the Prophet tells us of, *Iſai.* 5. 11, 12. men that had ſo debauched themſelves with drink, and enervated their minds by pleaſures, that *they regarded not the work of the* LORD, *neither conſidered the operation of his hands.* Such perſons having led their lives in ſuch a manner, as to wiſh there was no GOD to call them to account, would then perſwade themſelves there is none; and therefore ſtupidly aſcribe thoſe manifeſt demonſtrations of the infinite *Power* and *Wiſdom* of *GOD*, to a meer Nothing, rather than to their great Author. But may we not with as good reaſon, imagine a lighted Candle, a well made Culinary

Fire, a flaming Beacon, or Light-house, to be the work of *Chance* and not of *Man*, as thoſe Glories of the Heavens not to be the *Works of GOD*? For it is very certain that as much Wiſdom, Art, and Power, worthy of God, is ſhewn in the Lights of the Heavens; as there is in thoſe upon Earth, worthy of Man, which none can doubt were contrived and made by Man. And if from theſe mean contrivances and works of Man we conclude them to be the Works of Man; why not the grand, the amazing Works of the Heavens, ſurpaſſing all the Wit and Power of Man, why not theſe, I ſay, the Works of ſome Being as much ſuperior to Man? According to the argument of *Chryſippus* which ſhall conclude this Book. *If there be any Being that can effect thoſe things, which Man, although endowed with Reaſon, is not able to effect; that Being is*

cer-

certainly greater, and stronger, and wiser than Man. But Man is not able to make the Heavens; therefore the Being that did make them, excels Man in Art, Counsel, Prudence, and Power.

BOOK

BOOK VIII.

Practical Inferences

From the foregoing

SURVEY.

IN the foregoing seven Books having taken a View of what presents it self to us in the Heavens, and seen a Scene of the greatest grandeur, a Work well contrived, admirably adapted,

and every way full of Magnificence; all that now remains is, to endeavour to make theſe Views and Conſiderations uſeful to our ſelves. Which I ſhall do in the following Chapters.

CHAP. I.

The Exiſtence of GOD, collected by the Heathens from the Works of the Heavens.

THE firſt and moſt ready and natural Deduction we can make from ſuch a glorious Scene of Workmanſhip, as is before repreſented, is to conſider, *Who the Great Workman was?*

That the Author of all this glorious Scene of things was *GOD*, is ſuch a Concluſion, that even the moſt

ignorant and barbarous part of mankind have been able to make, from the manifeſt ſignals viſible therein; Signals ſo plain and concluſive, that *Tully's Stoick* (1) cites it as *Ariſtotle's* opinion, *That if there were ſuch a ſort of people, that had always lived under the Earth, in good and ſplendid Habitations, adorned with Imagery and Pictures, and furniſhed with all things that thoſe accounted happy abound with: and ſuppoſing that theſe People had never at any time gone out upon the earth, but only by report had heard there was ſuch a thing as a Deity, and a Power of the Gods; and that at a certain time afterwards, the earth ſhould open, and this people get out from their hidden manſions into the places we inhabit: when on the ſudden they ſhould ſee the Earth, the Seas, and the Heavens, perceive the magnitude of the*

(1) De Nat. Deor. L. 2. c. 37.

Clouds,

Clouds, and the force of the Winds, behold the Sun, and its grandeur and beauty; and know its power in making the Day, by diffuſing his light throughout the whole Heavens; and when the Night had over-ſpread the earth with darkneſs, they ſhould diſcern the whole Heavens beſpread and adorned with Stars, and ſee the variety of the Moon's Phaſes in her Increaſe and Decreaſe, together with the Riſings and Settings, and the ſtated and immutable Courſes of all theſe throughout all eternity; this people, when they ſhould ſee all theſe things, would infallibly imagine that there are Gods, and that thoſe grand Works were the Works of the Gods. Thus have we the opinion and concluſions of two eminent Heathens together, *Ariſtotle* and *Tully's Stoick*.

AND if the *Heavens* ſo plainly declare *the Glory of God; and the Firmament ſheweth his handy work* (2); if

(2) *Pſal.* 19. 1, *&c.*

those Characters, those Impreſſes of the Divine Hand are ſo legible, that *their line is gone out through all the earth; and their words to the end of the World, ſo that there is no Language, Tongue, or Speech where their voice is not heard*; nay if theſe things are ſuch, that even a ſubterraneous People would, at firſt ſight, conclude them to be GOD's *Work*; how daring and impudent, how unworthy of a rational Being is it, to deny theſe works to GOD, and aſcribe them to any thing, yea a meer *Nothing*, as *Chance* is, rather than GOD? *Tully's Stoick* laſt mentioned denieth him to be a Man, who ſhould do this. His words (z) are, *Who would ſay he is a man, who when he ſhould behold the Motions of the Heavens to be ſo certain, and the Orders of the Stars ſo eſtabliſhed, and all things*

(z) *Cicero* ibid. cap. 38.

ſo

ſo well connected and adapted together, and deny that Reaſon was here, and ſay theſe things were made by Chance, which are managed with ſuch profound counſel, that with all our wit we are not able to fathom them? What! ſaith he, when we ſee a thing moved by ſome certain device, as a Sphere, the Hours and many things beſides; we make no doubt but that theſe are the works of Reaſon. And ſo when we ſee the noble train of the Heavens rouled and wheeled about with an admirable pace, and in the moſt conſtant manner making thoſe anniverſary changes ſo neceſſary to the good and preſervation of all things; do we doubt whether theſe things are done by Reaſon, yea, by ſome more excellent and divine Reaſon? For, ſaith he, ſetting aſide the ſubtilties of Diſputation we may actually behold with our eyes, in ſome meaſure, the beauty of thoſe things which we aſſert are ordered by the DIVINE PROVIDENCE.

And then he enters into a long detail

of Particulars of this kind, too many to be named here.

Thus *Cicero*, throughout whoſe Works ſo many paſſages of this nature occur, that it would be endleſs to cite them: and therefore one that ſhews what his opinion was of the ſenſe of Mankind in the matter ſhall cloſe what he ſaith, and that is in his book *de Legibus* (4), where he ſaith, *Among all the tribes of Animals, none but Man hath any ſenſe of a God; and among mankind, there is no Nation ſo ſavage and barbarous, which although ignorant of what God it ought to have, yet well knows it ought to have one.*

And after the ſame manner Seneca (5), who inſtanceth in two things, to ſhew the deference we are apt to give to the general preſumption and conſent of mankind. One is in the

(4) L. 1, c. 8.
(5) Epiſt. 117.

Im-

Immortality of the Soul: the other is in the *Exiſtence of a Deity*; *which*, ſaith he, *among other arguments we collect from the innate opinion which all men have of the Gods: for there is no Nation in the World ſo void of Law and Morality, as not to believe but there are ſome Gods.* Nay ſo poſitive he is in this matter, that in another place he expreſly ſaith, *They lye that ſay, they believe there is no God. For although by Day they may affirm ſo to* thee, *yet by Night they are to* themſelves *conſcious of the contrary.* Much more could I cite out of this famous Heathen, but one paſſage relating to the Heavens ſhall ſuffice, and that is in his Diſcourſe ſhewing *Why evils befal good men, ſeeing there is a divine Providence* (6). He takes it for granted in this Diſcourſe, that there is ſuch a thing as a DIVINE

(6) *Quare bonis viris, &c.* c. 1.

POW-

POWER and PROVIDENCE *governing the World*; and he ſaith, *it was needleſs for him to ſhew that ſo great a Work* [as the World] *could not ſtand without ſome Ruler; that ſo regular Motions of the Stars could not be the effects of a fortuitous Force, and that the impulſes of Chance muſt be oftentimes diſturbed and juſtle: that this undiſturbed Velocity which bears the weight of ſo many things in the Earth and Seas, ſo great a number of heavenly Lights, both very illuſtrious, and alſo ſhining by a manifeſt diſpoſal, muſt needs proceed by the direction of ſome eternal Law: that this can never be the order of ſtraggling Matter; neither is it poſſible for things fortuitouſly and raſhly combined, to depend upon, and manifeſt ſo much art.* Divers of which matters he proceeds to inſtance in.

Thus *Cicero* and *Seneca*: to whoſe evidences I might have added many others, particularly a great deal out of

of *Plato* (the *divine Plato*, the *Homer of Philosophers*, as he is called by the Ancients). But it would be needless as well as tedious, since these two former have given us the sense of Mankind, as well as their own opinion in the matter.

CHAP. II.

GOD's Perfections demonstrated by his WORKS.

AS GOD's *Works* have been shewn to be manifest Demonstrations of his *Existence*; so they are no less of his *Perfections*, particularly of his infinite *Power*, *Wisdom* and *Goodness*; inasmuch as every Workman is known by his Work. A Palace that should have nothing defective in Situation, Beauty, or Conveni-

venience, would argue the Architect to have been a man of ſagacity, and skilful in Geometry, Arithmetick, Opticks, and all other Mathematical Sciences ſerving to make a man a compleat Architect, yea to have ſome Judgment in Phyſick, and Natural Philoſophy too. And ſo this glorious Scene of *GOD's Works*, the Heavens, plainly demonſtrate the Workman's infinite *Wiſdom* to contrive, his *Omnipotency* to make, and his infinite *Goodneſs*, in being ſo indulgent to all the Creatures, as to contrive and order all his Works for their good. For what leſs than *Infinite* could effect all thoſe grand things, which I have in this Diſcourſe ſhewn to be manifeſt in the Heavens? What *Architect* could build ſuch vaſt Maſſes, and ſuch an innumerable company of them too, as I have ſhewn the Heavens do contain? What *Mathematician* could ſo exactly adjuſt their Diſtances?

What

What *Mechanick* ſo nicely adapt their Motions, ſo well contrive their Figures, as in the very beſt manner may ſerve to their own conſervation and benefit, and the convenience of the other Globes alſo? What *Naturaliſt*, What *Philoſopher* could impregnate every Globe with a thing of that abſolute neceſſity to its conſervation, as that of Gravity is? What *Optician*, what *Chymiſt* could ever have hit upon ſuch a noble Apparatus for Light and Heat, as the Sun, the Moon, and the Stars are? could amaſs together ſuch a pile of Fire as the Sun is? could appoint ſuch Lights as the Moon and other Secondaries are? None certainly could do theſe things but GOD.

CHAP.

CHAP. III.

Of GOD's Relation to us, and the Duties resulting from thence.

IT appearing from the last Chapter how great a *Being* the CREATOR is, it is time to consider what Relation he stands in to us, and what is due from us to him. His Relation to us is that of CREATOR; and as such, of *Conservator*, *sovereign* LORD and *Ruler*, one that hath an absolute power over us, and all things belonging to us, that can subject us to what Laws he sees fit, and that can reward or punish us as we deserve. And in this case, the least we can do, is to *revere* and *fear* him at all times, to *worship* and *serve* him with all our power, to *comply* with his

his holy Will ſincerely and heartily, and to *obey* him in all things he hath either forbidden or enjoyned. And conſidering alſo how great *Indulgence* and *Love* the CREATOR hath ſhewed in his Works throughout the Univerſe, it naturally follows that we ought to be truly *Thankful* to him for his Mercy and Kindneſs, and to *Love* him for his Love and Goodneſs.

THESE kind of Concluſions are ſo natural, that the very Heathens have in ſome meaſure made them. Thus *Cicero*'s *Stoick* before cited, (1) *Quid vero? hominum Ratio non, &c. What? doth not Man's Reaſon penetrate as far as even the very Heavens? For we alone of all Animals have known the Riſings, Settings and Courſes of the Stars: by mankind it is that the Day, the Month,*

(1) De Nat. Deor. L. 2. c. 61.

and

and Year is determined, that the Eclipses of the Sun and Moon are known, and foretold to all futurity, of which Luminary they are, how great they will be, and when they are to happen. Which thing the mind contemplating, it receives from hence (2) *the knowledge of the Gods: from whence arises Piety; to which is joined Justice, and the other Virtues, from which springs that blessed Life which is equal unto, and like that of the Gods themselves, and in no respect yielding to those celestials, except in immortality, which is not necessary to happy living.* And in his Book *de Legibus* (3) Cicero brings in his Collocutor saying, *Sit igitur hoc à principio persuasum, &c.* i. e. *Let this be what every member of the Commonwealth is fully convinced of from the beginning, That the Gods are Lords*

(2) Some read it instead of *Accipit ad cognitionem Deorum; Accipit ab his cognitionem Deorum.*

(3) Lib. 2. c. 7.

and

and Governours of all things; that whatsoever things are done, they are managed by their influence, rule and divinity; that they merit a great deal of mankind; and observe what every one is, what he doth, what he admits into his mind, with what mind, what Piety he cultivates Religion; and that they take an account both of the Righteous and Wicked. For, saith he, *Minds that are indued with these Principles, will scarce ever depart from that opinion that is useful and true.* And a little after (4) one of the Laws arising from hence he saith is, *Let men approach the Gods with purity, let them practise Piety: for he that doth otherwise God himself will be the avenger of.* This purity and sincerity is so necessary a concomitant of Religion and divine Worship according to *Cicero*, that he makes it in another place to be that which distinguishes Religion from

(4) *Cap.* 8.

Superſtition (5). *Cultus autem Deorum eſt optimus, &c. But that religion, that worſhip of the Gods is the beſt, the pureſt, the holieſt, and fulleſt of Piety, that we always revere and worſhip them with a pure upright and undefiled mind and voice. For,* ſaith he, *not only the Philoſophers, but our Forefathers have diſtinguiſhed Superſtition from Religion;* which he aſſigns the difference of, and then tells us, *That the one hath the name of a Vice, the other of Praiſe.*

THUS as the Heathens have by the Light of Nature deduced the Exiſtence and Attributes of God from his Works, and particularly thoſe of the Heavens; ſo have they at the ſame time collected what the principal Duties are which Men owe to God; ſo reaſonable, ſo natural, ſo manifeſt they are to all mankind.

(5) De Nat. Deor. L. 2. c. 28.

CHAP.

CHAP. IV.

Lactantius his Argument against the Heathen Gods.

THE next Inference shall be one made by the eloquent *Lactantius* (1), *Argumentum illud quo colligunt universa Cœlestia Deos esse, &c.* i. e. *That argument whereby they conclude the Heavenly bodies to be Gods, proveth the contrary: For if therefore they think them to be Gods, because they have such certain and well contrived rational Courses, they err. For from hence it appears that they are not Gods, because they are not able to wander out of those paths that are prescribed them: whereas if they were Gods,*

(1) Institut. L. 2. c. 5.

they would go here, and there, and every where without any compulsion, like as animals upon the Earth do, whose wills being free, they wander hither and thither as they list, and go whithersoever their minds carry them.

Thus *Lactantius* with great reason refutes the Divinity of the *Heavenly Bodies*; which on the contrary are so far from being Gods, and Objects of divine honour and worship, that some of them have been taken to be places of Torment. Thus *Comets* particularly, which must needs have a very unequal and uncomfortable temper of Heat and Cold, by reason of their prodigiously near Approaches to the Sun, and as great Recesses from it. Thus, according to the before commended Sir *Isaac Newton*'s (2) computation, the Comet in 1680 in its Perihelion

(2) Principia p. 466.

was

was above 166 times nearer the Sun than the Earth is; and conſequently its Heat was then 28000 times greater than that of Summer: ſo that a Ball of Iron as big as the Earth, heated by it, would hardly become cool in 50000 years. Such a place therefore if deſigned for Habitation, may be imagined to be deſtined rather for a place of Torment than any other living.

But above all, the *Sun* it ſelf, the great Object of Heathen Worſhip, is by ſome of our own learned Countreymen ſuppoſed to be probably the place of *Hell.* Of which Mr. *Swinden* hath written a Treatiſe called, *An Enquiry into the Nature and Place of Hell.*

CHAP. V.

This Survey of the Heavens teaches us not to overvalue the World, with Reflections of the Heathen Writers thereupon.

FROM the conſideration of the prodigious Magnitude and Multitude of the Heavenly bodies, and the far more noble Furniture and Retinue which ſome of them have more than we, we may learn not to overvalue this World, not to ſet our Hearts too much upon it, or upon any of its Riches, Honours or Pleaſures. For what is all our Globe but a Point, a Trifle to the Univerſe! a Ball not ſo much as viſible among the greateſt part of the Heavens, namely the Fixt Stars. And if Magnitude or Reti-

Retinue may dignify a Planet, *Saturn* and *Jupiter* may claim the preference: or if Proximity to the moſt magnificent Globe of all the Syſteme, to the Fountain of Light and Heat, to the Center, can honour and aggrandize a Planet, then *Mercury* and *Venus* can claim that dignity. If therefore our World be one of the inferiour parts of our Syſteme, why ſhould we inordinately ſeek and deſire it? But above all, why ſhould we unjuſtly graſp at it, and be guilty of Theft or Rapine, Lying or Cheating, or any Injuſtice or Sin for it? Why ſhould we ſacrifice our Innocence for it, or part even only with a Good Name for it, which *Solomon* ſaith (1) *is rather to be choſen than great Riches?* Why ſhould we do this, if we were ſure of gaining the whole terraqueous

(1) Prov. 22. 1.

Globe, much leſs do it for a ſmall pittance of it, as the beſt Empire in the world is? For as our bleſſed Saviour argues, Matt. 16. 26. *What is a man profited, if he ſhall gain the whole World, and loſe his own Soul? or what ſhall a Man give in exchange for his Soul?*

But paſſing over the arguments which Chriſtianity ſuggeſts, let us ſee how ſome of the Heathen Writers deſcant upon this ſubject. *Pliny* (2) is very pathetical in his Reflections, when he had ſhewn what little portions of the earth were left for us, and what large tracts were rendred (as he thought) uſeleſs, the frigid Zones being frozen up with exceſſive Cold, the torrid Zone being burnt up (as the opinion then was) with as exceſſive Heat, and other parts drowned by the Sea, Lakes and Rivers, and others covered with large Woods, Deſarts, or barren Mountains: he then exclaims thus, *How to-*

(2.) Nat. Hiſt. L. 2. c. 68.

portio-

portiones terræ, &c, i. e. *These little parcels of land*, which are left for our habitation, *yea as many have taught, this Point of the world* (*for no other is the Earth in respect of the Universe*) *this is the Matter, this the Seat of our Glory: here it is we bear our Honours, here we exercise our Authority, here we covet Riches; here mankind makes a bustle; here we begin our civil wars, and soften the earth with mutual Slaughters.* And then having shewn how by fraud and violence men strive to enlarge their estates, saith he, *What a little part of those lands doth he enjoy? and when he hath augmented them even to the measure of his Avarice, what a poor pittance is it that his dead body at last possesseth?* Thus *Pliny*. And after the same manner *Seneca* reflects upon the matter (3), when he shews how Vertue tends to make a man compleatly happy; among other things, by prepa-

(3) *Nat. Quæst.* L. 1. Præf.

ring

ring him for the ſociety of God, by enabling the Mind to ſoar above the things here below, and to make him laugh at the coſtly Pavements of the Rich, yea the whole Earth with all its wealth. *Nec enim poteſt*, ſaith he, *ante contemnere porticus*, &c. i. e. *A man can never be able to ſlight the ſtately Piazzas, the noble Roofs ſhining with Ivory, the curiouſly clipped Woods, and the pleaſant Rivulets conveyed to the houſes, until he hath ſurveyed the whole world, and ſpying from above our little globe of Earth, covered in a great meaſure by the Sea, and where it is not, in far and near ſqualid, and either parched with heat or frozen with cold, he ſaith to himſelf, Is this that Point which by fire and ſword is divided among ſo many nations? O how ridiculous are the bounds of mortals! The* Iſter *bounds the* Dacians, *the* Strymon *the* Thracians, Euphrates *the* Parthians, *the* Danube *parteth the* Sarmatians *and* Romans, *the* Rhene

gives

gives bounds to Germany; the Pyrenees to France and Spain; and between Egypt and Ethiopia lie the vast uncultivated Sandy Deserts. If any could give human Understanding to Ants, would not they too divide their Molehill into divers Provinces? And when thou lifteſt up thy ſelf in thy truly great Province, and ſhalt ſee the armed hoſts paſſing here, and lying there, as if ſome great matter was to be acted, conſider that this is no more than the running of Ants in a Molehill. For what difference between them and us, but only the meaſure of a little body? That is but a point in which thou faileſt, in which thou wageſt war, in which thou diſpoſeſt of Kingdoms. But above there are vaſt ſpaces, to whoſe poſſeſſion the Mind is admitted, provided it brings but little of the Body along with it, that is, purged of every vile thing, and that it is nimble and free, and content with ſmall matters. And ſo he goes on to ſhew that when the Mind is once arrived

to

to thoſe celeſtial regions, how it is come to its proper habitation; is delivered from its bonds; hath this argument of its divinity, that divine things delight and pleaſe it, and is converſant with them as its own; that it can ſecurely behold the Riſings and Settings and various courſes of the Stars; that it curiouſly pries into all thoſe matters, as nearly appertaining to it ſelf: that then it contemns the narrow bounds of its former habitation, it being but a trifling ſpace, of a few days journey, from the utmoſt limits of *Spain* to the rich *Indies*; whereas the celeſtial regions afford a path for the wandering of the ſwifteſt Star for 30 years, without any reſtance; in which regions he tells us the Mind arrives to the knowledge of thoſe things at laſt, which it had before long enquired after, and there begins to know GOD. Thus *Seneca*; which ſhall ſuffice for this third Inference.

CHAP.

CHAP. VI.

That we ſhould aſpire after the Heavenly State.

I Shall deduce only one thing more from my preceding View of the Heavens, and that is to aſpire after the Heavenly State, *to ſeek the things that are above.* We are naturally pleaſed with new things, we take great pains, undergo dangerous Voyages, to view other Countries: with great delight we hear of new diſcoveries in the Heavens, and view thoſe glorious Bodies with great pleaſure through our Glaſſes. With what pleaſure then, ſhall departed happy Souls ſurvey the moſt diſtant regions of the Univerſe, and view all thoſe glorious Globes thereof, and their noble

Appen-

Appendages with a nearer View. Only let us take especial care to *set our affections on things above*; to be *spiritually, not carnally minded*; and so to *run the race which Christ hath set before us*, that we may arrive to that *Place which he hath prepared* for his faithful servants, that he may *receive us unto himself, that where he is, we may be also; in whose presence is fulness of joy, and at whose right hand are pleasures for evermore.*

FINIS.

ADDENDUM

To pag. 59. after accompanying Jupiter.

—And a moſt ſagacious Contrivance this is, manifeſting the Preſence and Conduct of the CREATOR, in thus chooſing this Proportion I ſpake of, rather than any other. For ſhould the power of Gravity (for inſtance) have been ſo conſtituted, as to decreaſe in the Proportion of the Cubes (inſtead of the Squares) of the Diſtances reciprocally; although it might be poſſible to adjuſt a Velocity, and I may add, a Direction too, ſo as to make Bodies deſcribe perfect Circles, yet the leaſt Exceſs or Defect of Velocity, or the leaſt Obliqui-

liquity of the Direction, would make them deſcribe Spiral Curves, either aſcending *in infinitum*, or elſe deſcending to the Center. And ſuppoſing the Orbs (in which thoſe Bodies move, and which are ſuppoſed, as I ſaid, to be made in proportion of the Cubes) to be perfectly Circular, the leaſt Adventitious Force, even but of an Atom, abating or increaſing the Velocity, or changing the Direction, would bring on the aforeſaid Inconveniences.

And if the great CREATOR, &c.

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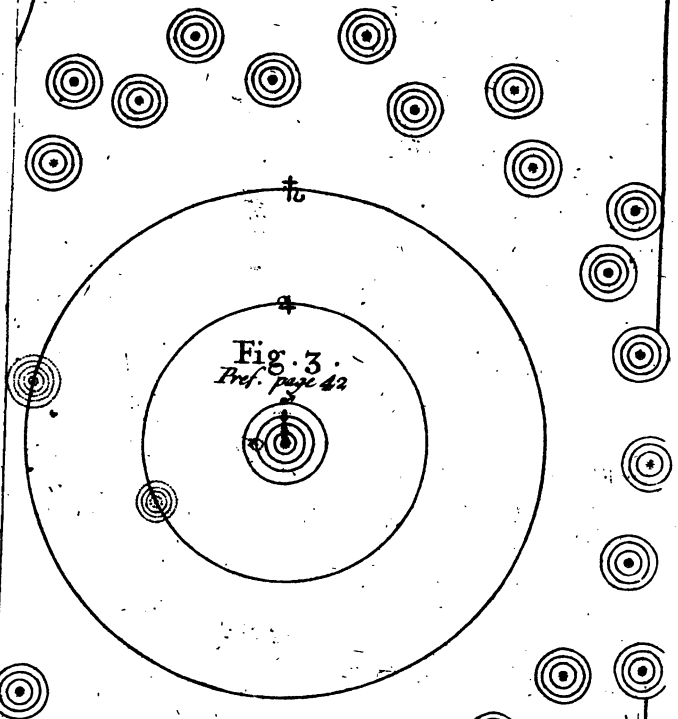

Fig. 3.
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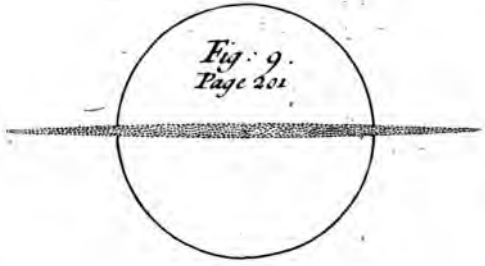

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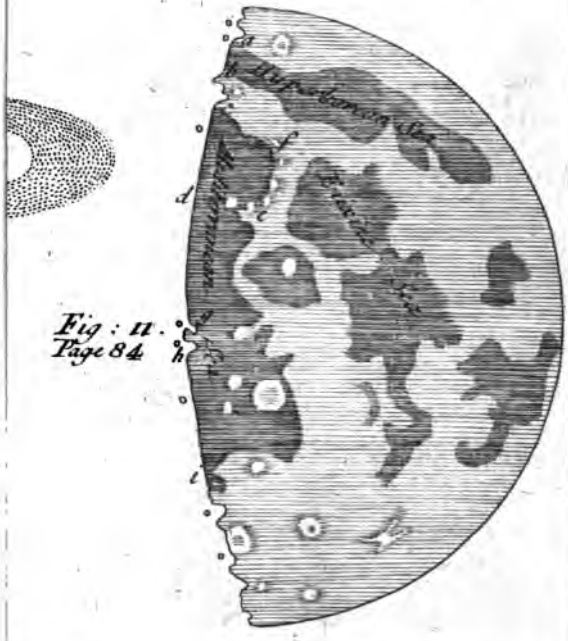

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THE END.

CORRIGENDA.

PAG. 50. lin. 1. dele (*as to me it seems very probable*). P. 67. l. 12. dele *but*. P. 87. l. ult. after *visible to us*, reads *in one part of their Orbits, and again disappear in other parts of them. But these Systemes* &c.

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